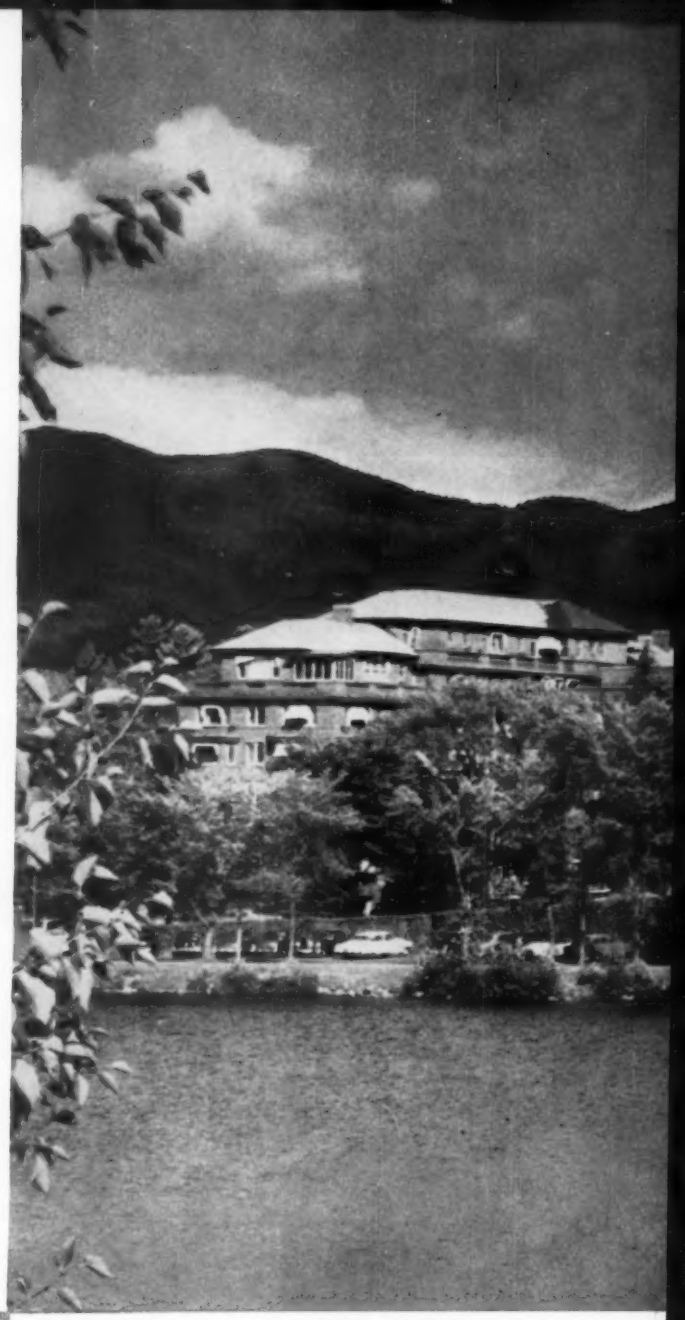
Power Engineering

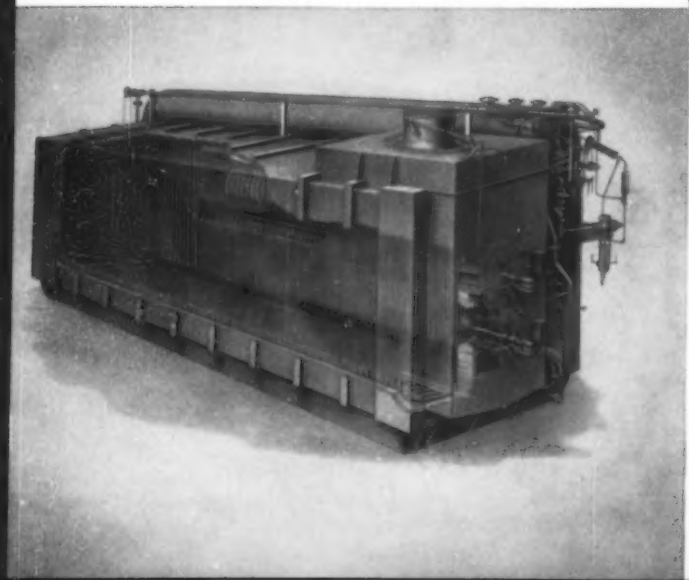
MARCH 1961

TVA's Experimental EHV Line Section Goes Into Operation.... 48
Coal—From Mine to Boiler: Power for Strip Mining of Coal.... 49
Epicyclic Gears and High-Speed Motor for Low-Speed Pump.... 52
American Power Conference Meets in Chicago, March 21-23.... 54
A Pictorial History of Big Plant Construction at Breed..... 55
Will Refrigerating Condenser Circulating Water Boost Power?.. 58
Does Production of Power Pollute Our Nation's Rivers?..... 60
Why Surface Condenser Backwashing Systems Are Important.. 64
New Turbine Blade Design Used on Sewaren's No. 5 Unit..... 68
Penelec Tests 460-kv Line for Power Project in Pennsylvania.. 70
Automating Boiler Feed Pumps in Utility Power Plants..... 72
AEP's Air-Blast Circuit-Breakers Are Faster and Bigger..... 75
AIEE Winter Meeting Discloses New Concepts and Techniques.. 76
New High-Voltage Motor Controls Introduced to Power Field.. 78
How to Contain Large Turbine Parts for Blast-Cleaning..... 82
ATOMICS ... Special Bi-Monthly Technical Report..... 40
Editorial Comment and Department Listings..... 3

PUMPED STORAGE AND STEAM CAPACITY FACTOR 45

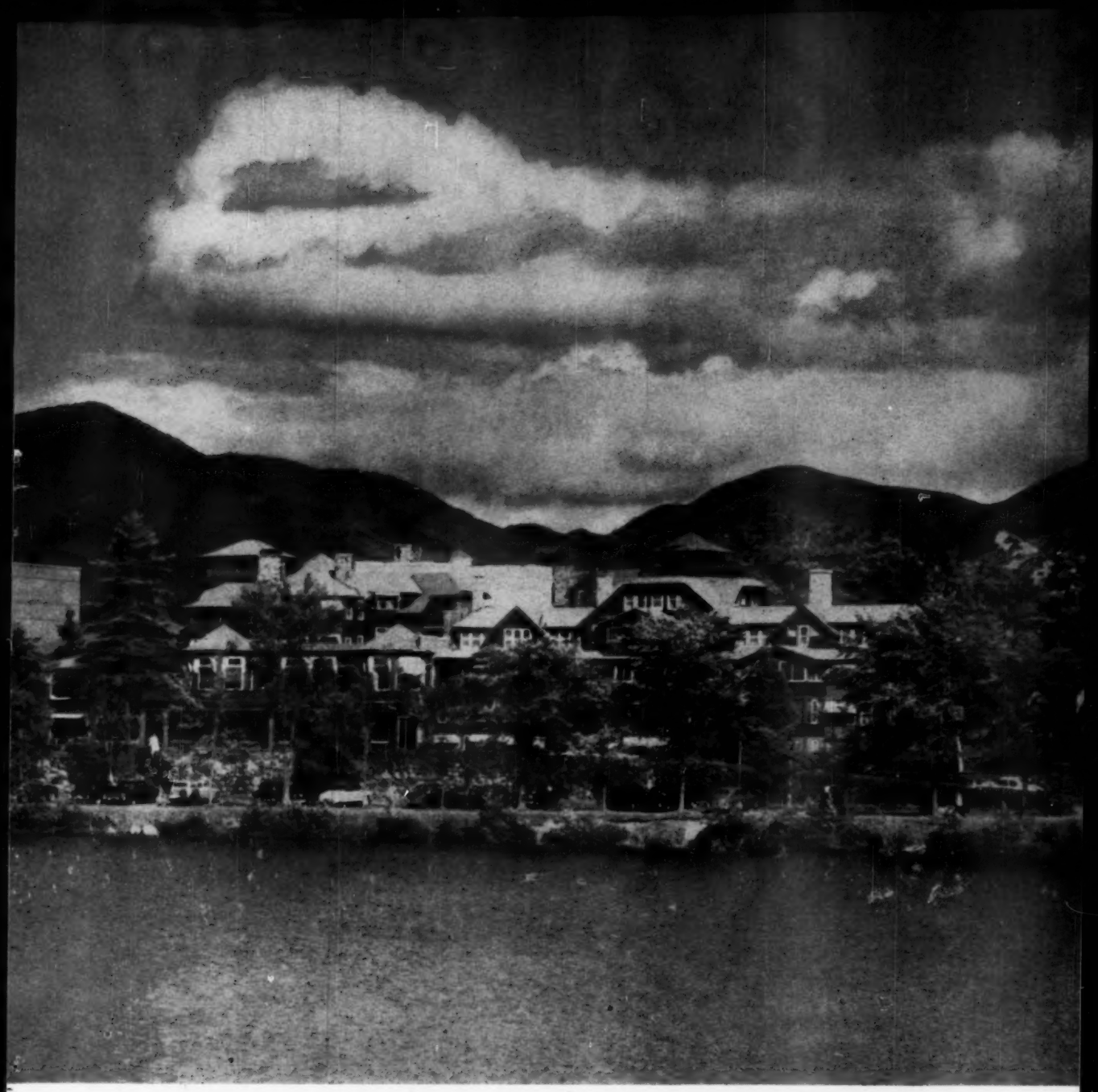
Lake Placid Club Members and Guests are Three Times Cozier via Steam Generation by B&W





Renowned winter resort generates own steam for heating, electric power and laundry . . . finds surest answer in dependable B&W Package Boiler.

At the Adirondacks' famous Lake Placid Club, steam plays a vital role in maintaining an atmosphere of relaxation and comfort for members' and guests' enjoyment. The Club's appealing air of seclusion is won in part by privacy of location . . . so that vital heat, electricity and laundry-steam must come entirely from the Club's own facilities. The Club can also supply power in emergencies to the local hospital and fire department . . . so boiler dependability and ease of operation are critical factors in meeting these crucial and expanding steam requirements. That's why the Club followed the recommendation of Pope and Evans—consulting engineers, and added a B&W Package Boiler. With a steam



capacity of 30,000 lb per hr at an operating pressure of 250 psi with superheat to 450 F, this automatically fired unit will give efficient, economical service over a wide load range. And the Club knows that at any time in the life of the boiler—10, 20 or 30 years from now—B&W's nationwide service organization will be promptly and economically available if needed.

Providing these vital steam services for a rambling Adirondack year 'round vacation Club is further evidence-in-action of dependable steam generation by B&W. Whatever the steam requirement . . . whatever fuel is most economical . . . B&W can fill the bill. Your local B&W representative has all the fuel facts on *your* area. Call him soon. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W—THE NATION'S LEADING MANUFACTURER OF INDUSTRIAL BOILERS

G-970-18

B&W

THE BABCOCK & WILCOX COMPANY

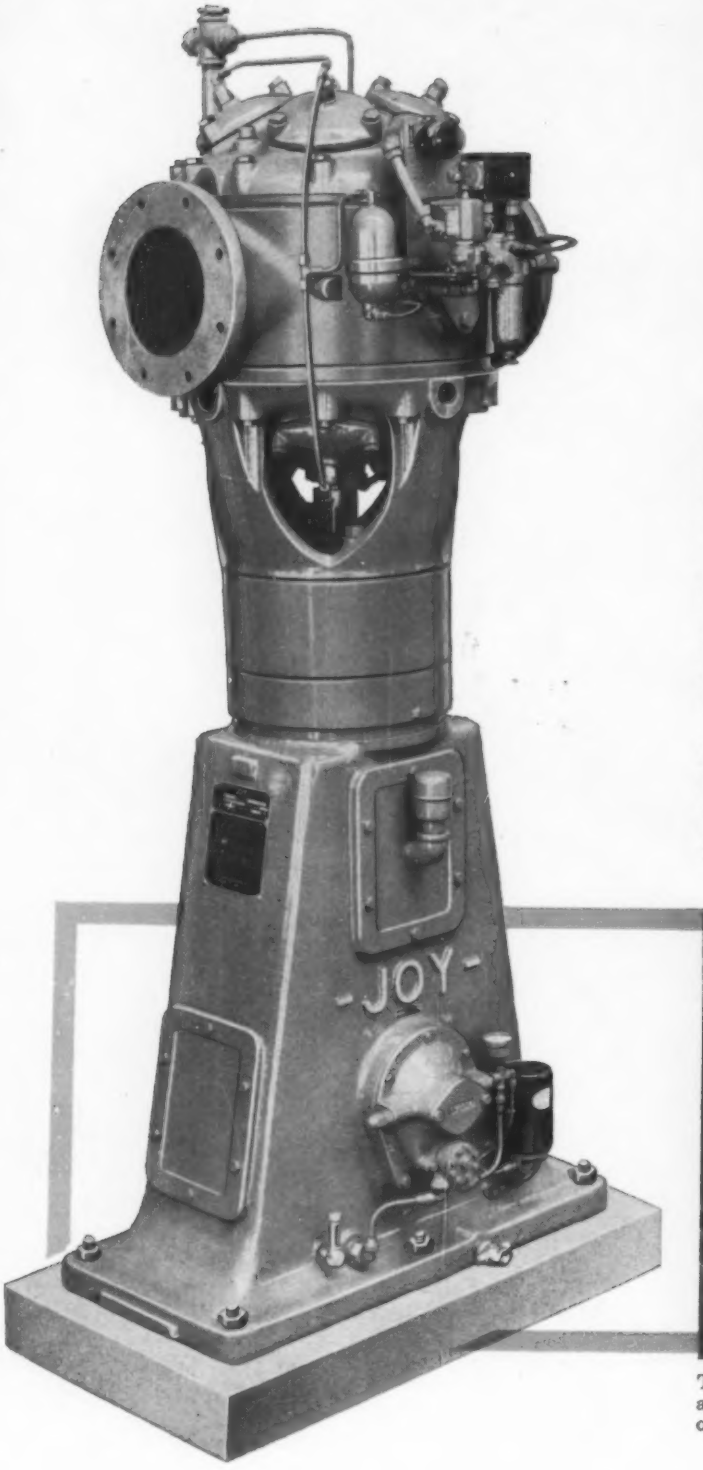
BOILER DIVISION

For more data circle 505 on Post Card

VERTICAL DESIGN

gives you oil-free air
with low maintenance

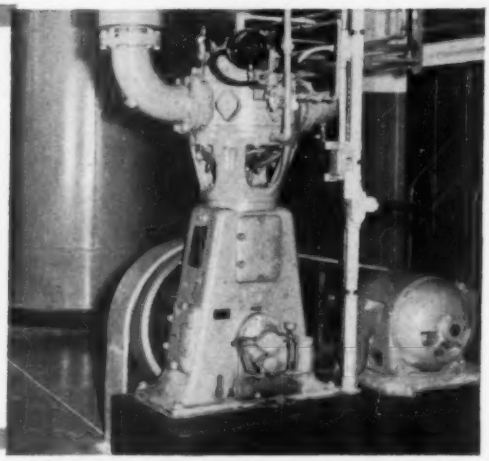
JOY WGO-9 Compressors



Because the Joy WGO-9 oil-free compressor is designed vertically, carbon ring wear is greatly reduced. Equal pressure on all sides of the piston rings produces even wear and reduced maintenance. The piston need never be rotated.

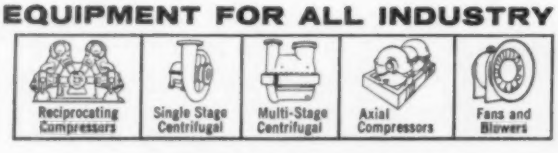
All Joy oil-free compressors are equipped with carbon graphite piston rings of an exclusive T-block design. They require no lubrication and compensate automatically for wear so that blow-by is virtually eliminated for the life of the ring. Joy compressor owners report ring life of 8000 operating hours or more.

WGO-9 compressors are available from 95 to 1528 cfm, 15 to 150 hp. Joy also builds complete lines of larger oil-free units including centrifugal and axial types as large as 15,000 hp. For complete information on the WGO-9 write for bulletin 2415-56C.



This WGO-9 supplies oil-free air for instruments and controls at a large central station powerhouse of a mid-western utility.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more data circle 502 on Post Card

Power Engineering

POWER ENGINEERING is published monthly at 308 E. James Street, Barrington, Illinois. Telephones: Dunkirk 1-1840, (Chicago) NEwcastle 1-0488.

Change of Address: Send to POWER ENGINEERING, Circulation Division, Barrington, Illinois. Please supply your position title, company name, company address. Please allow 60 days to make the change effective.

Subscription Information: Published monthly, price in the U.S. and possessions $10 per year; in Canada $11 per year; other countries $12 per year; single copies $1.

Indexed in the Industrial Arts Index and the Engineering Index on file in public and many private libraries.

Microfilm Edition: Request prices from University Microfilms, Inc., Ann Arbor, Mich. All volumes since 1948.

Copyright 1961 by Technical Publishing Co, Barrington, Illinois. Accepted as a controlled circulation publication, Concord, New Hampshire.

REACTION!

Last month we published an article "Needed—A Real Power Conference and Show." This was a straw in the wind, to see what men in the field think of the present system.

We have received a great number of answers from readers whose opinions we value most highly. Key people in industry, utilities, technical societies, and engineering firms have given us their views both pro and con. It is most enlightening to find that our suggestion has received widespread acceptance.

This article did not suggest an ***additional*** *power conference; on the contrary, it proposed a consolidation of many existing meetings. Plus—a really good Power Show!*

Suggesting a specific attack on the problem was not our intention; however, several key people in the power field have already suggested the American Power Conference as a starting point. This sounds quite logical, and should receive consideration.

Bob McCaw
EDITOR

EDITORIAL STAFF

Editorial Director	Richard H. Morris
Editor	Robert F. McCaw
Special Projects Editor	Chester R. Earle
Equipment Editor	Marian E. Heniken
Associate Editor	Welden Reynolds
Associate Editor	John Papamarcos
Editorial Assistant	William T. Marshall
Editorial Assistant	Mildred Novosel
Editor of ATOMICS	Andrew W. Kramer
Art Director	James E. Wilcox
Art Editor	Alice K. Wheatley
Artist-Draftsman	Oswald R. Balchen

Regular Departments

Editorial Comment	3	Construction News	84
Engineers' Preview	4	New Engineering Books	86
Tracers	8	Reader Service Post Cards	93
Current Catalogs	31	Equipment News	96
News Reel	62	Advertisers' Index	108
Handbook	80	Circulation This Issue	43,370

Engineers' Preview

OF NEWS AND COMING EVENTS IN THE POWER FIELD

THE ELECTRIC INDUSTRY has more than 40 million kilowatts of new capacity on order and scheduled for service, Edison Electric Institute reports. About 85 per cent of this is to be in operation by the end of 1963; 12,455,100 kw are scheduled to go into operation this year.

At the end of 1960, the generating capability of the total electric utility industry of the contiguous U.S. reached more than 175 million kw. This was more than 7 per cent over the capability at the end of 1959. During 1960 the total capacity of new electric generating units, 4000 kw and larger, placed in commercial operation was 11,113,730 kw.

REGIONAL PLAN for the building of three power stations with an annual output of 2600 million kwh on the upper reaches of the Stora Lule river in Arctic Sweden is being considered by the Swedish State Power Board. The scheme, including the construction of reservoirs, would call for investments of $125 million plus power transmission lines. All three power plants are to be encased in the bedrock.

CONSTRUCTION BUDGET of more than $116 million for 1961 — more than half of it slated for electric power plant construction — has been announced by American Electric Power Co. This compares with 1960 expenditures of $100 million. Bulk of the AEP System power-plant construction in 1961 will be carried on by Appalachian Power Co. The subsidiary is expected to spend close to $62 million. Included in this is work on Appalachian's 440,000-kw, two-dam hydro project at Smith Mountain on the Roanoke River in Virginia and the new 225,000-kw generating unit at its Clinch River Plant at Carbo, Va.

RECORD electric peak load in 1960 of 2,797,000 kw, is reported by Public Service Electric and Gas Co, 8 per cent higher than the 1959 peak load. This occurred on August 30, and on the same day the company had a record day's output of 49,442,800 kwh.

On December 13, a day's sendout of 6,068,953 therms of gas set a new maximum, 9 per cent above that of 1959. The company's total output of electricity in 1960 amounted to 13,356,903,600 kwh, and 900,937,644 therms of gas were sent out, 5 per cent and 12 per cent, respectively, greater than in 1959. Plans for 1961 call for the expenditure of $150,000,000 for facilities to keep pace with continually increasing demands for electric and gas service.

COMMONWEALTH EDISON CO's Chicago Central Division recently worked 2,000,000 man-hours without a disabling injury. This record won for them citations from the Greater Chicago Safety Council and the Edison Electric Institute, as well as the company's safety achievement plaque.

VALUABLE publication is a 6 by 9, 32-page booklet entitled, I Want to Know About the Electric Industry, the 12th edition of which has just been published by the Edison Electric Institute. In concise text and convenient tables, this booklet gives the answers to 29 questions frequently asked EEI. Here are some typical examples of these questions:

How fast is the U.S. moving in electrical production and capability? What about future electric industry expansion? What are electric companies doing to develop atomic energy? How much fuel is used in electricity production? What's the ownership trend in new generating installations?

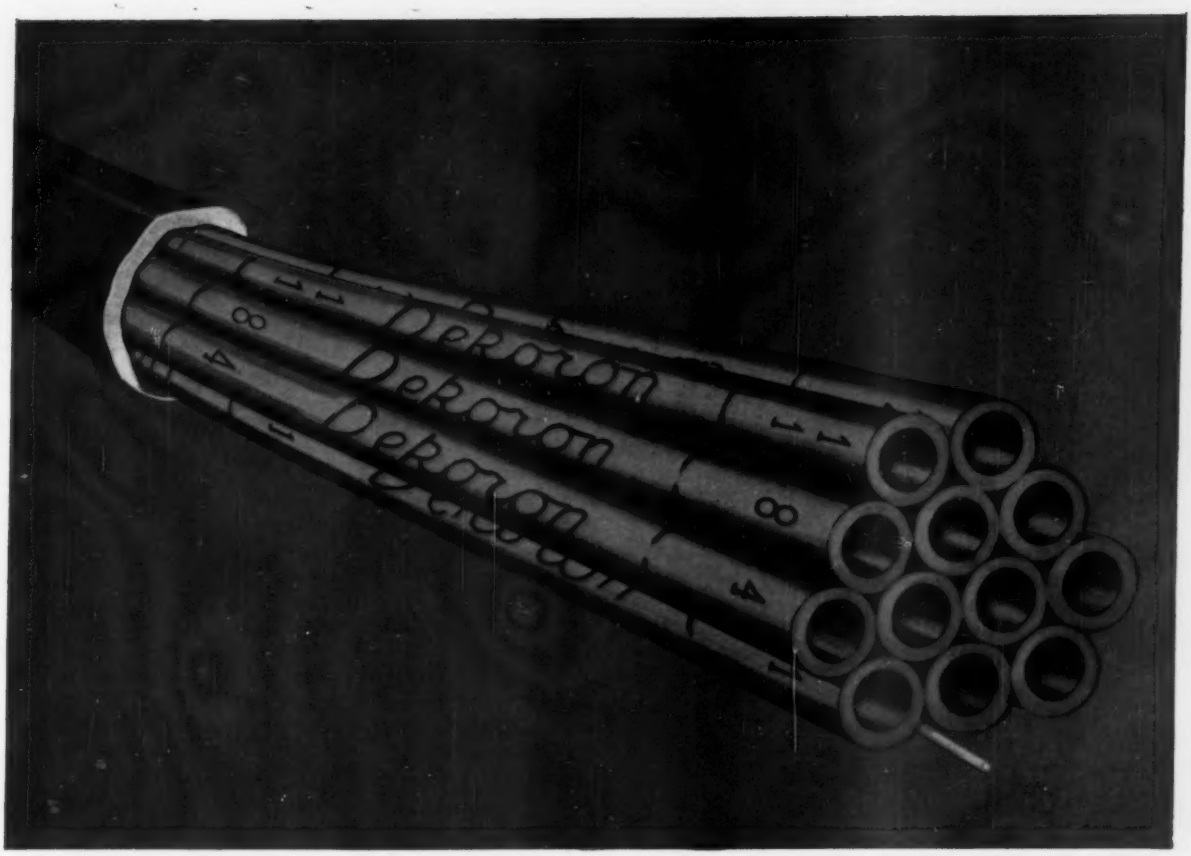
Tables show specific figures to answer questions like these. Data cover not only the investor-owned utilities, but also municipal, Federal, cooperative and industrial capacity and production. The data are of the highest authenticity and should prove invaluable to engineers and executives in every industry in the country.

For a copy of the booklet write to Edison Electric Institute, 750 Third Ave, New York 17, N.Y., and a single copy will be sent without charge.

PRODUCTION and shipment of power boiler units in 1960 is expected to represent a generating capacity of 83 million pounds of steam per hour — approximately 3 per cent less than in 1959 and 38 per cent less than the record year 1957. So reports the Business and Defense Services Administration, U.S. Department of Commerce.

Shipments in 1960 were approximately 15 per cent less than the annual average over the last decade. Shipments scheduled for 1961 on orders placed in 1960 and earlier by domestic electric power systems, industrial purchasers, and overseas accounts are expected to show the first year-to-year increase since 1957, according to the power equipment industry. The annual value of the industry's sales are approximately $500 million.

Shipments of steam turbine generators (4000 kw and larger) con-



New Dekoron instrument harness design uses core of Anaconda precision copper tubes

The new parallel-construction Dekoron* "Metl-Cor" instrument harness offers many interesting features. All the tubes are number-coded for faster installation. Because the tubes are parallel, there are no low spots or moisture traps – and as tubes need not be straightened, take-offs are easier to make. The tubes are protected from corrosion and physical damage by a sheath of improved polyethylene. New Dekoron "Metl-Cor," a product of Samuel Moore & Company, Mantua, Ohio, is available in lengths up to 1000 feet.

In this new product, as in other Dekoron instrument tube bundles, Samuel Moore & Co. uses Anaconda Copper Tubing because it consistently meets its rigid quality requirements and is available in unusually long lengths. Special care is taken by Anaconda to maintain dimensional accuracy and uniform soft temper throughout the length. It also makes sure that surfaces are clean, smooth, and bright, free from dirt, dust, or metal chips.

LONG LENGTHS. For such uses as in instrumentation, Anaconda can produce this precision copper tube in coils up to 2200 feet for ¼" O.D.–up to 1400 feet for ⅜" O.D.–and up to 1000 feet for ½" O.D.

QUALITY TUBE AND CREATIVE TECHNICAL SERVICES. Whatever your requirements for precision copper tubing-instrumentation or capillary tubing, or restrictor tubes – Anaconda specialists can help you find the most economical way to do the job. For such technical assistance, see your Anaconda representative, or write: Anaconda American Brass Company, Box 1031, Waterbury 20, Connecticut.

*Registered trademark of Samuel Moore & Co. 6070

ANACONDA®

INSTRUMENTATION TUBING

Anaconda American Brass Company

For more data circle 503 on Post Card

tinued downward in 1960, BSDA reports, to a low comparable to that in 1956. New orders are expected to continue their decline in the first half of 1961 but should rise by the end of the third quarter, reflecting the trend of the over-all national economy. Shipments in 1961 will rise moderately because of orders booked in the last two years, according to industry sources.

The steam turbine-generator industry is continuing to follow a cycle that has become familiar over the past 10 years. The steam turbine generator provides approximately 80 per cent of all power supplied in the United States today, and is engineered and manufactured only for specific applications that meet the individual requirements of the utility or industry concerned. The resultant long lead time (2–3 years) creates considerable fluctuation in yearly production.

NUCLEAR ENGINEERING at the University of Illinois has come of age with approval by the Board of Trustees for establishment of an advanced educational program leading to the PhD degree in this field. Action on the new program came two years after the University's initiation of nuclear engineering at the master's degree level.

CLEAVER-BROOKS has in production a salt water conversion evaporator, of the long-tube flash type, which will have a capacity of 275,000 gpd. This unit, with a record 28 stages, will be installed at St. Thomas in the Virgin Islands and is reported to be the largest sea water conversion plant in the United States and its possessions.

PROMINENTLY represented at the New York 1964-65 World's Fair will be the investor-owned electric industry. Ernest R. Acker, chairman of Edison Electric Institute's World's Fair Committee, has announced the formation of a new corporation to handle EEI's participation in the Fair. It is called Power & Light Exhibit, Inc, and has already selected a 44,000-sq ft lot for an exhibition building. VEK Associates has been selected to create the architectural concept, theme, exhibits plan and programming for the Power & Light Exhibit project. Acker, who is board chairman of Central Hudson Gas & Electric Corp, is serving as P & LE president.

KULJIAN CORP of Philadelphia has been awarded a contract by the government of West Bengal, India, covering complete consulting services for a new super thermal power station for the Calcutta area. Approximate cost of the new power facility, which will have an initial capacity of 300,000 kw, is estimated at $55 million.

A second stage is planned for 1962 which will double the installed capacity of the station to 600,000 kw, ranking it among the largest of its kind in Asia. Total cost of the two stages is estimated at $100 million.

Located near Bandel on the Bhagirathi Hooghly River, when in full operation the station will use approximately 260 million gpd for cooling its condensers and as make-up water for its boilers.

DEVELOPMENT LOAN FUND has approved three U.S. Government loans totaling $27,700,000, for economic-development activities in Yugoslavia. Procurement with DLF funds in all three cases will be restricted to the United States.

One loan involves power equipment. This $14 million loan will assist the addition of a 125,000-kw thermal generating unit to a power plant at Kosovo. In 1959, the DLF signed a $9 million loan for construction of the 62,500-kw first phase of this power plant.

Major equipment to be purchased will include a 125,000-kw turbine generator with boiler and auxiliary equipment, and a 220-kv substation with interconnections to the 110-kv substation associated with first-phase plant units now under construction.

Energoprojekt, a Yugoslav enterprise, will have over-all responsibility for engineering and construction of the project. Consulting engineering services will be provided by the U.S. firm of Gibbs & Hill, who are serving with the first-phase project.

NEARLY HALF of the electric loans approved by the Rural Electrification Administration during 1960 will finance facilities to generate and transmit more power in rural areas, the U.S. Department of Agriculture reports.

Of a total of $254.5 million in REA electric loans made in 1960, about $120 million or 47.1 per cent went for generation and transmission purposes. In 1959, these loans accounted for 27 per cent of the total approved.

The 1960 total of loans for generation and transmission facilities was swelled by approval of a $25.8 million loan to the Southern Illinois Power Coöperative, a new borrower at Steeleville, Ill. This was the largest single loan in REA's 25½ years of operation. It will finance a steam generating plant of 99,000-kw capacity and 354 miles of transmission line.

THERE'S A NEW international standard of length established by the 11th General Conference on Weights and Measures, which met in Paris.

The new definition of the meter as 1,650,763.73 wavelengths of the orange-red line of krypton 86 will replace the platinum-iridium meter bar which has been kept at Paris as an international standard for length since 1889 under the Treaty of the Meter.

The new definition of the meter relates it to a constant of nature, which is believed to be immutable and can be reproduced with great accuracy in any well-equipped laboratory. Thus it is no longer necessary to return the national standards of length to Paris at periodic intervals in order to keep length measurements on a uniform basis over the world.

MEETINGS: ASME's Boiler and Pressure Vessel Committee, jointly with the National Board of Boiler and Pressure Vessel Inspectors, will hold a public meeting Mar 12–17 at the Barringer Hotel in Charlotte, N.C.

ASME's Oil and Gas Power Division conference and exhibit will be held at the Jung Hotel in New Orleans, Apr 10–13. Theme is Engine Fuels and the Future.

Fourth biennial Gas Dynamics Symposium, held under the joint auspices of the American Rocket Society and Northwestern University, is scheduled for Aug 23–25 at Northwestern University.

DEARBORN'S FULL-RANGE PRODUCT LINE SERVES ALL YOUR WATER TREATMENT NEEDS

*Check the Scoreboard!...How many of these does your plant need?**

Boiler Water Treatment, Sludge Conditioners and Anti-Foams	Dearborn® 66, 201, 240, 241, 242, 245, 247, 250, 251, 253AF, 281, 291, 659, 669, 679, 689.
Cooling Water Treatments	Polychrome® 501, 505, 525 and Dearborn 533 with Endcor® A; Dearborn 860 with Endcor B; Dearborn 143, 846, 862, 888.
Steam and condensate Corrosion Inhibitors	Super Filmeen® and Super Filmeen 20—filming amines Alkameen® and Alkatrol®—neutralizing amines.
Biocides	Dearcide® 702, 703, 707, 711, 717.
Coagulant Aids	Aquafloc 420, 425, 430.
Process Antifoams	Ex-Foam® 630, 631, 635, 636.
Scale and Deposit Removers	Scale-Cleen®—inhibited dry acid. Dearborn 134—inhibited hydrochloric acid.
Consulting Service	Before and after sale—covering all your potential water problems from source through reuse to disposal.
Chemical Feeding Equipment; ion exchange resins	Most complete of any water treatment company.
Experience	Three-quarters of a century—longest of any Company in the field.

*Partial list of products. Most are available in economical powder or easy-to-use briquette form.

Unfortunately, there's no panacea—no universal cure-all—for industrial water treatment problems.

That's why Dearborn's full-range product line—the most complete in the industry—is critically important. Because of it, Dearborn engineers need not "make do" with something almost good enough. They have available the exact chemical combination best suited to the job—combinations developed by Dearborn research laboratories and proved in Dearborn's 75 years of experience—longest in the water treatment field. Many of these product combinations are protected by U. S. patents and are available only from Dearborn.

Dearborn's water treatment division has eleven district offices in the United States and Canada and a trained field staff of 90 to serve you—before and after a sale. Call your nearest representative today. Or write for our Bulletin outlining Dearborn services and how they can end your water treatment problems.

DEARBORN CHEMICAL COMPANY

General Offices: Merchandise Mart, Chicago 54 • Dallas • Des Plaines, Ill. • Ft. Wayne • Honolulu Linden, N.J. • Los Angeles • Nashville • Omaha • Pittsburgh • Toronto • Havana • Buenos Aires

For more data circle 504 on Post Card

Tracers

COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ AEP System's big new Breed Plant in Indiana was dedicated last October (see POWER ENGINEERING, December, page 57). Now comes this interesting bit of news from AEP president **Philip Sporn**, to complete the picture:

> . . . apropos of your quoting me that although the plant as of the time of the dedication was a 475-Mw plant, I expected that its ultimate capability would be over 500 Mw — you may be interested in the fact that during last week (Dec 18) we actually carried 504 Mw on an hourly integrated basis.

Along this same line, TVA's new 500-Mw generating unit at Widows Creek Steam Plant has been producing 535 Mw, is expected to exceed 550.

▶ **T. H. Batt** of the Western Electric Co writes in comment on our special issue (Jan) which featured a report on unconventional power sources:

> For several years I have been receiving POWER ENGINEERING at my office. My engineers and I have enjoyed the many interesting and useful articles we find in it. I feel that in the January issue you have really outdone your previous wonderful record.

Ellwood A. Johnson, of Rural Coop Power Assn, Elk River, Minn, writes of Jan: "This issue has proved invaluable. . . You are to be congratulated."

▶ **W. R. Wilson**, assistant superintendent of Inland Steel Co's electrical department, has sent in the following comment on a statement we made in the December, 1960 issue (page 3) in reporting on Penelec's new 460-kv transmission line:

> You state, "A 460-kv line is capable of carrying 16 times as much electricity as a similar line operating at 115 kv since capacity increases in direct proportion to the square of the voltage." Unless the current carrying capacity of the line has been increased, I believe the statement should read ". . . capable of carrying 4 times as much electricity . . ."
>
> Power consumed in a load of fixed resistance is proportional to the square of the voltage, but since a transmission line is simply a means of conveying power to the load, and is not the load itself, the square relationship does not apply.

We can't agree that the 460-kv line is capable of carrying only four times as much power as one operating at 115 kv. True, the line is only a means of conveying energy and is not the load itself, but it is still true that the amount of power that can be carried over a line is proportional to the square of the voltage. The loss in any electrical system is proportional to the square of the current, and since any transmission line has resistance, the I^2R loss in the line must be added to the I^2R loss in the load itself. If R_t is the resistance of the transmission line and R_l the resistance of the load, the total loss is $I^2 (R_t + R_l)$. Since by raising the voltage the current is reduced, the losses vary inversely as the square of the voltage.

Conversely, the weight, or the cross sectional area of a conductor varies inversely as the square of the voltage, when the power transmitted, the distance, and the line loss are fixed.

Thus, in the case of the Pennsylvania line, if the amount of power, the distance, and the line loss remain fixed, with 460 kv, it could have a cross sectional area $\frac{1}{4}^2$ or 1/16 that, with a voltage of 115 kv.

Of course, when it is claimed that the higher voltage line can carry 16 times the power of the lower voltage line, it implies that the line would be stressed to the limit. In practice this would not be done. Theoretically, however, the 460-kv line can carry 16 times as much power as one operating at 115 kv.

▶ **Dr. Pier A. Abetti**, manager of General Electric's Project EHV, has been appointed manager of the newly-expanded Electrical Engineering Laboratory of the company's General Engineering Laboratory in Schenectady.

Westinghouse small steam turbine department and industrial gas turbine department have been merged. The new department will be headed by **R. C. Twombly. K. S. Kramer** and **F. Anthony** are the engineering and sales managers for the new department.

Frederick J. Zimmermann, inventor of the Zimmermann Process for the disposal of organic waste, has been elected vice-president plants and engineering of Sterling Drug, Inc. He will continue to head two Sterling divisions: the Salvo Division (until recently Salvo Chemical Corp), and the Zimpro Division, which handles all matters relating to the Zimmermann Process.

Samuel B. Nelson, formerly chief engineer of water works of the Los Angeles Department of Water and Power, has been named general manager and chief engineer of the Department. He succeeds **William S. Peterson**, who has retired.

Charles F. Luce, attorney of Walla Walla, Wash., has succeeded Dr. William A. Pearl as administrator of the Bonneville Power Administration.

Expansion of the responsibilities of **D. J. Nairn**, manager, product sales, and **E. P. Hansen**, chief engineer, to include all products of the thermal power department except water conditioning, has been announced by Allis-Chalmers.

S. M. Austin has been appointed manager of the water conditioning products section of the A-C thermal power department.

In addition, the thermal power department has announced steam condenser appointments as follows: **W. E. Ellingen**, sales manager; **R. A. Bernhardt**, chief engineer, and **R. A. Wilson**, consulting engineer.

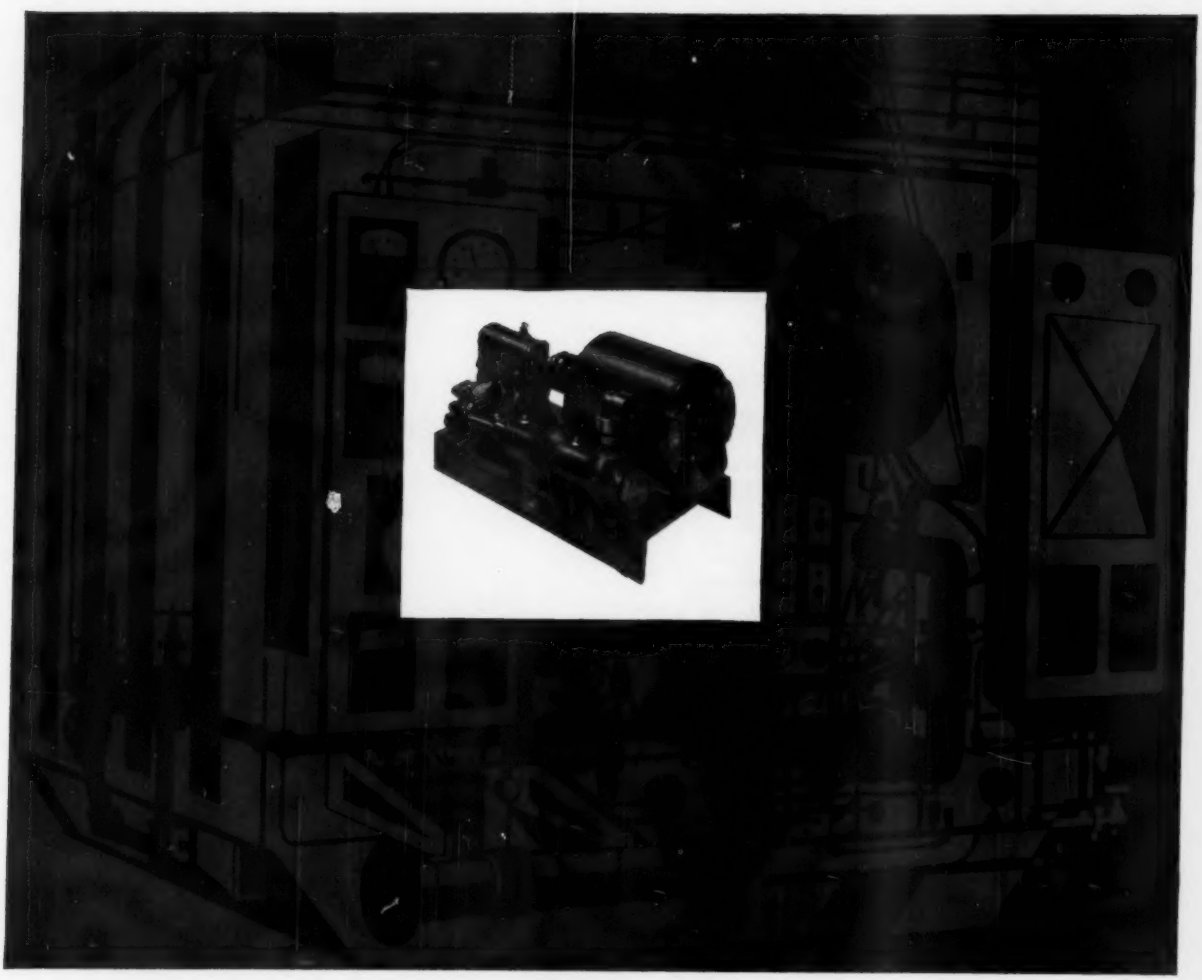
GET LOW-COST DEPENDABLE PROTECTION FOR LOW PRESSURE BOILERS WITH AN H20® CHEMICAL METERING PUMP

Benefits include lowest cost ever, a new record for low maintenance requirements, and easier servicing. The H20 controlled volume pump not only costs less to purchase and install, but it costs less to operate at the peak of efficiency than any other comparable chemical feeder. The H20 metering pump is based on the same principles that have made Milton Roy controlled volume pumps famous. But in the interests of economy, every working part has been simplified and redesigned for production line manufacturing. There's been little sacrifice in accuracy, and none at all in dependability.

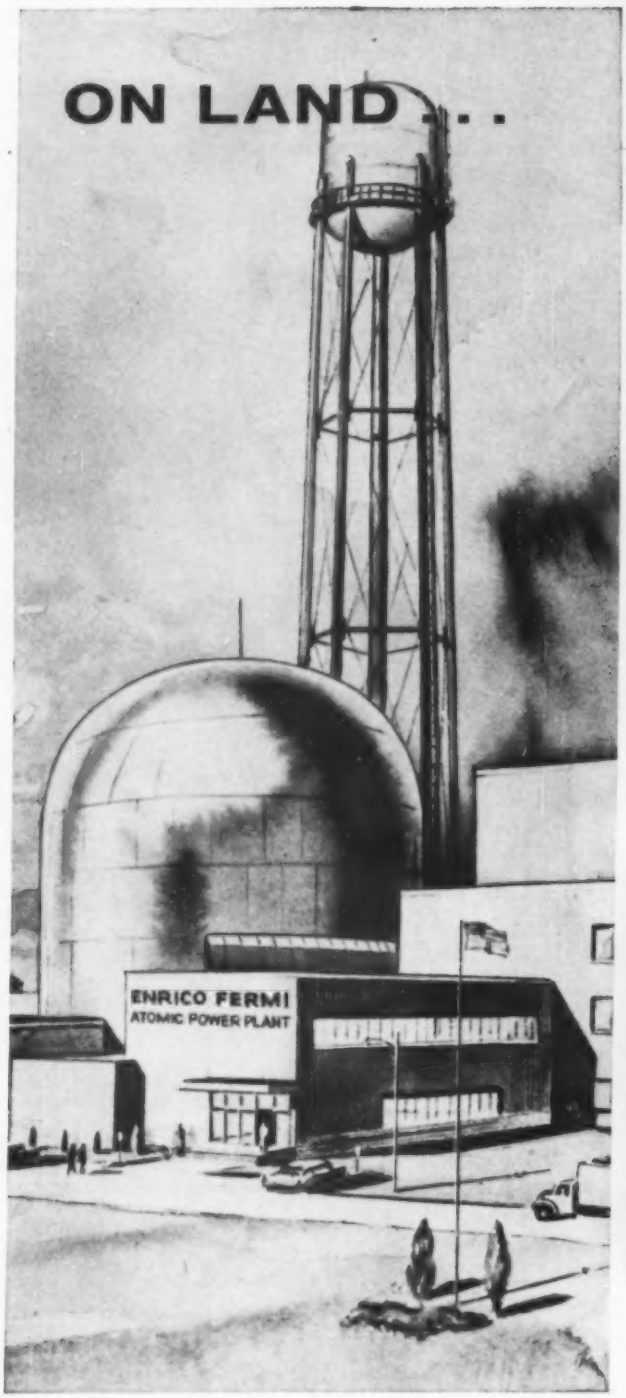
Around the clock, you can depend on your H20 pump to meter the necessary mild, non-corrosive treatment chemicals to your boiler feed, cooling tower, and process make-up water. The H20 is available immediately from stock. Even completely piped and assembled chemical feed systems with simplex or duplex H20 pump and 50 or 100 gallon steel tank can be shipped within 24 hours. They're ready to go to work immediately, accurately and economically metering chemicals against pressures to 600 psi.

GET COMPLETE FACTS *on the H20 pump and packaged chemical feed systems in Bulletin 558. Write Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.*

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS



For more data circle 505 on Post Card

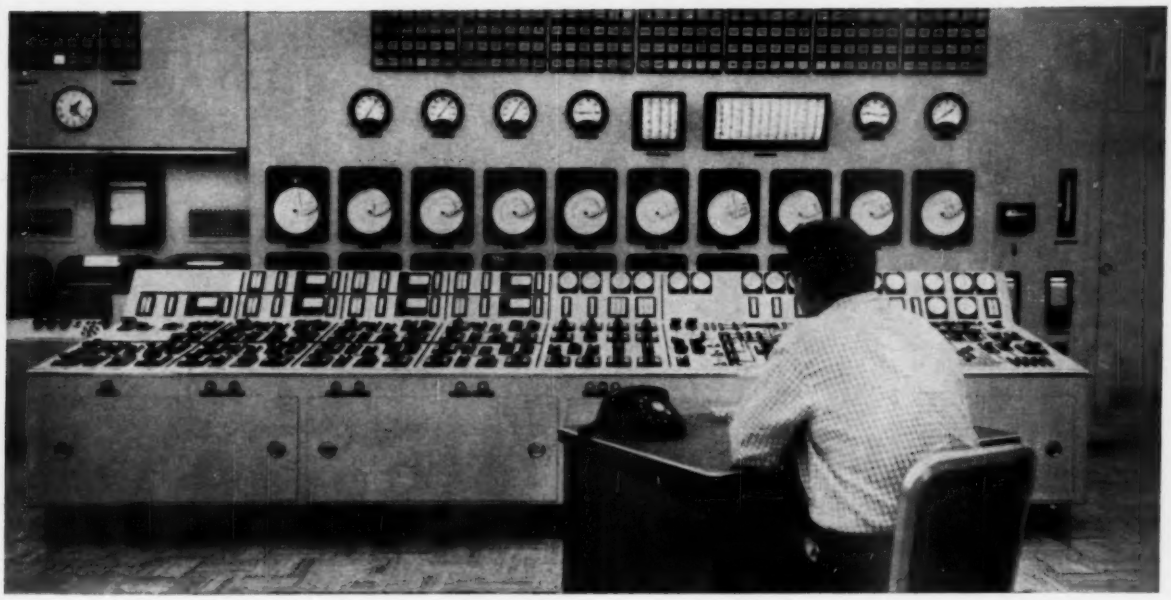


At the Enrico Fermi Atomic Power Plant, instruments and controls for both the "fast neutron breeder" reactor and the steam plant which it will "fire" are being furnished by Bailey.

Many of the new ships such as this super-carrier, USS Ranger, operate their boilers by Bailey Meter Control. Cargo ships, tankers, and passenger liners as well as Naval ships improve the economy and safety of their steam plants thru use of Bailey controls.

At the Thomas H. Allen Electric Generating Station of the City of Memphis, Tenn., Bailey operating indicators and controls for combustion, feed water, and steam temperature are centralized on the mechanical benchboard directly ahead, while the operating records which reflect trends are mounted on the vertical boards. A Bailey METROTYPE Information System, center left in the photo, scans, monitors, and logs functions usually assigned to strip-chart recorders.

IT'S BAILEY. . .



for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to assure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

There's a Bailey District Office or Resident Engineer close to you. Check your phone book, or write direct.

A144-2

Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

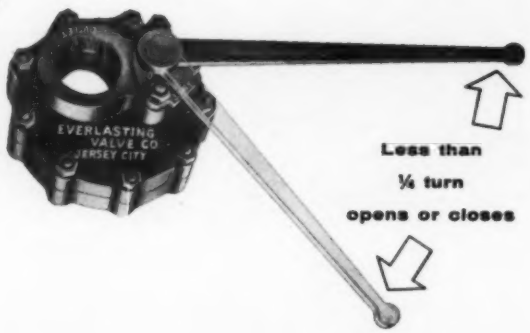
In Canada—Bailey Meter Company Limited, Montreal

For more data circle 506 on Post Card

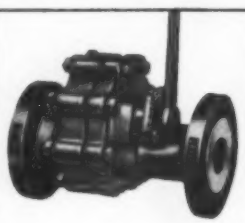
WHEN YOU NEED.....

- Quick Action
- Leak-Proof Seal
- Minimum Pressure Drop
- Straight-through full flow
- Valves that cannot wedge or jam
- Self-grinding rotating disc

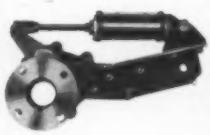
SPECIFY EVERLASTING VALVES



BOILER BLOW-OFF
Quick acting, also handwheel operated "Y" and angle types. For pressures up to 600 psi.

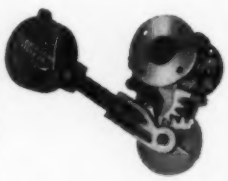


GENERAL SERVICE
Where drop-tight seal and full flow is essential.



CYLINDER OPERATED
Can be remotely controlled, electrically or manually.

STEAM JACKETED
Assures free flow of viscous materials.



WEIGHT-OPERATED
For automatic drains or emergency shut off.

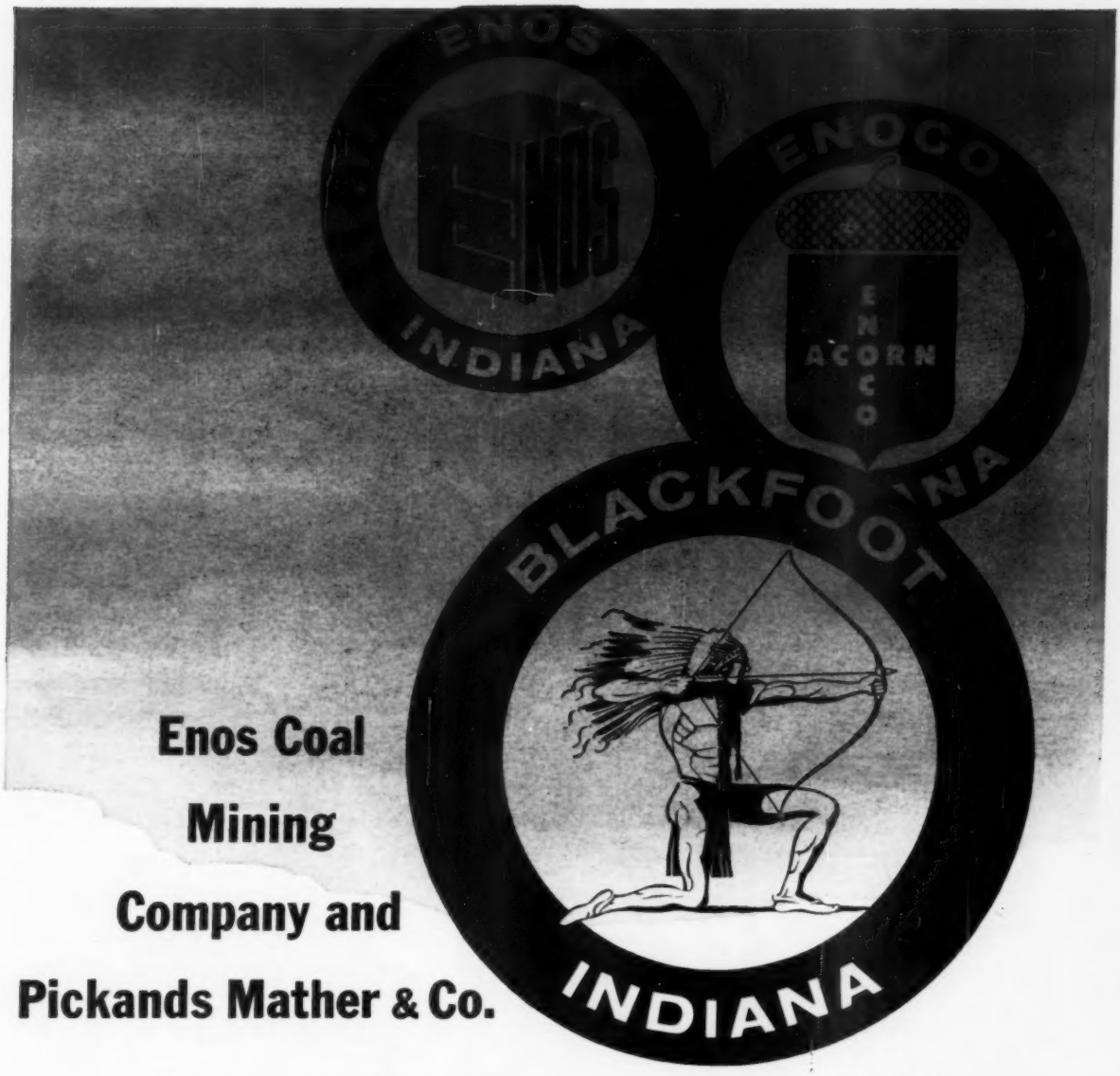
For more information write for these bulletins →

Everlasting VALVES

EVERLASTING VALVE CO., 47 FISK STREET, JERSEY CITY 5, N. J.

EV-607

For more data circle 507 on Post Card



Enos Coal Mining Company and Pickands Mather & Co.

. . . announce the acquisition of the Blackfoot Mine of the Blackfoot Coal and Land Corporation by Enos Coal Mining Company on January 1, 1961.

. . . and the purchase of the Inter-State Coal Company by Pickands Mather & Co., exclusive sales agent for Enos Coal Mining Company. Enos Coal Mining Company operates the Enos and Enoco Mines in Indiana.

Inter-State Coal Company is a wholly-owned subsidiary of Pickands Mather & Co. and will continue as the sales agent for the Blackfoot Mine.

PICKANDS MATHER & CO.

CLEVELAND 14, OHIO

CHICAGO • CINCINNATI • DETROIT • DULUTH • ERIE • GREENSBORO
INDIANAPOLIS • NEW YORK • PITTSBURGH • ST. LOUIS • WASHINGTON

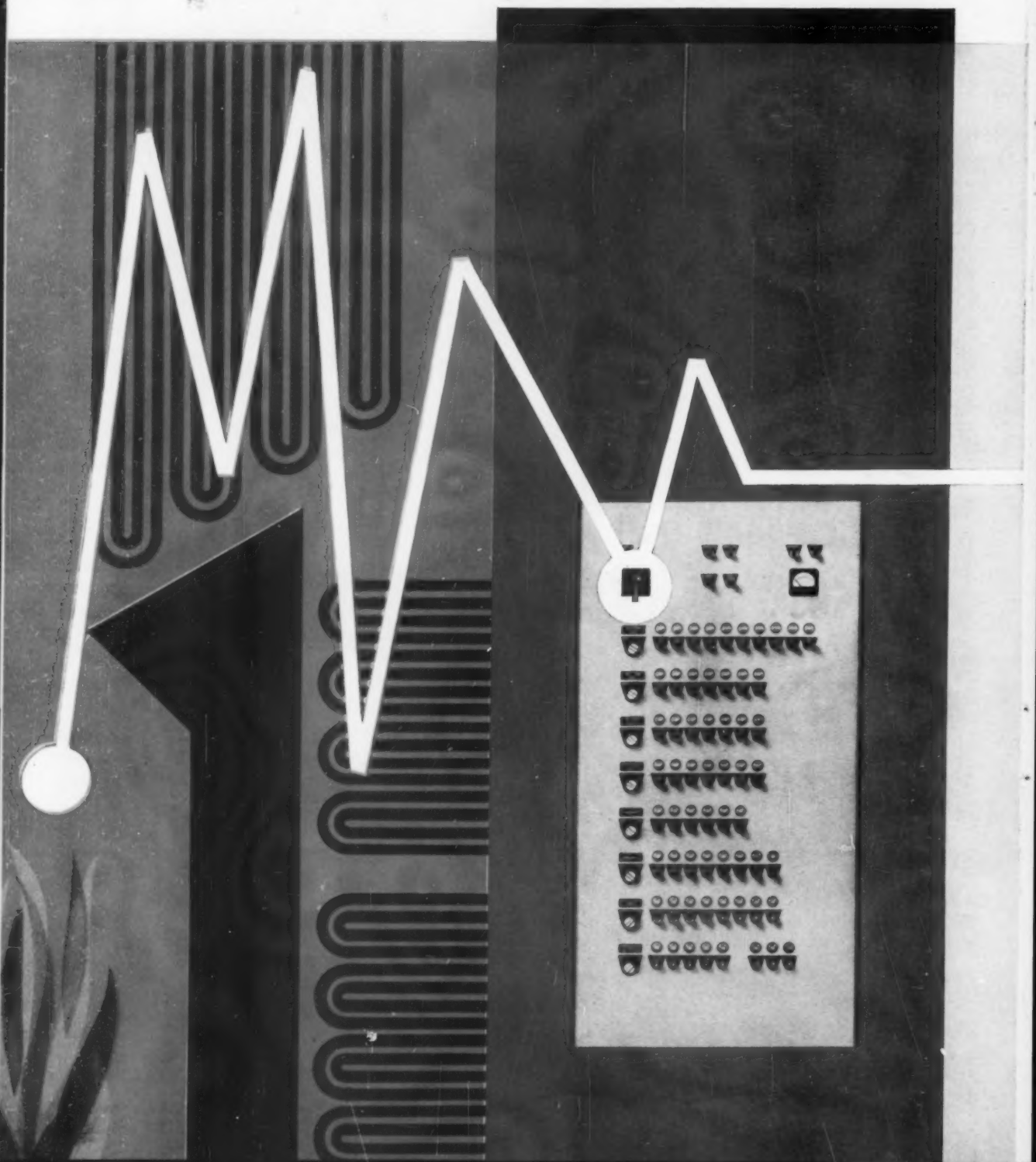
Serving Industry Since 1883

IRON ORE • PIG IRON • SILVERY • COAL • COKE • FERROALLOYS

For more data circle 508 on Post Card

Diamond developed for more economical power

MONITORMATIC...NEW SELF-CONTROL FOR MORE EFFICIENT BOILER CLEANING



Optimum frequency of blower cycling is assured with Monitormatic . . . Diamond's completely automatic boiler cleaning system.

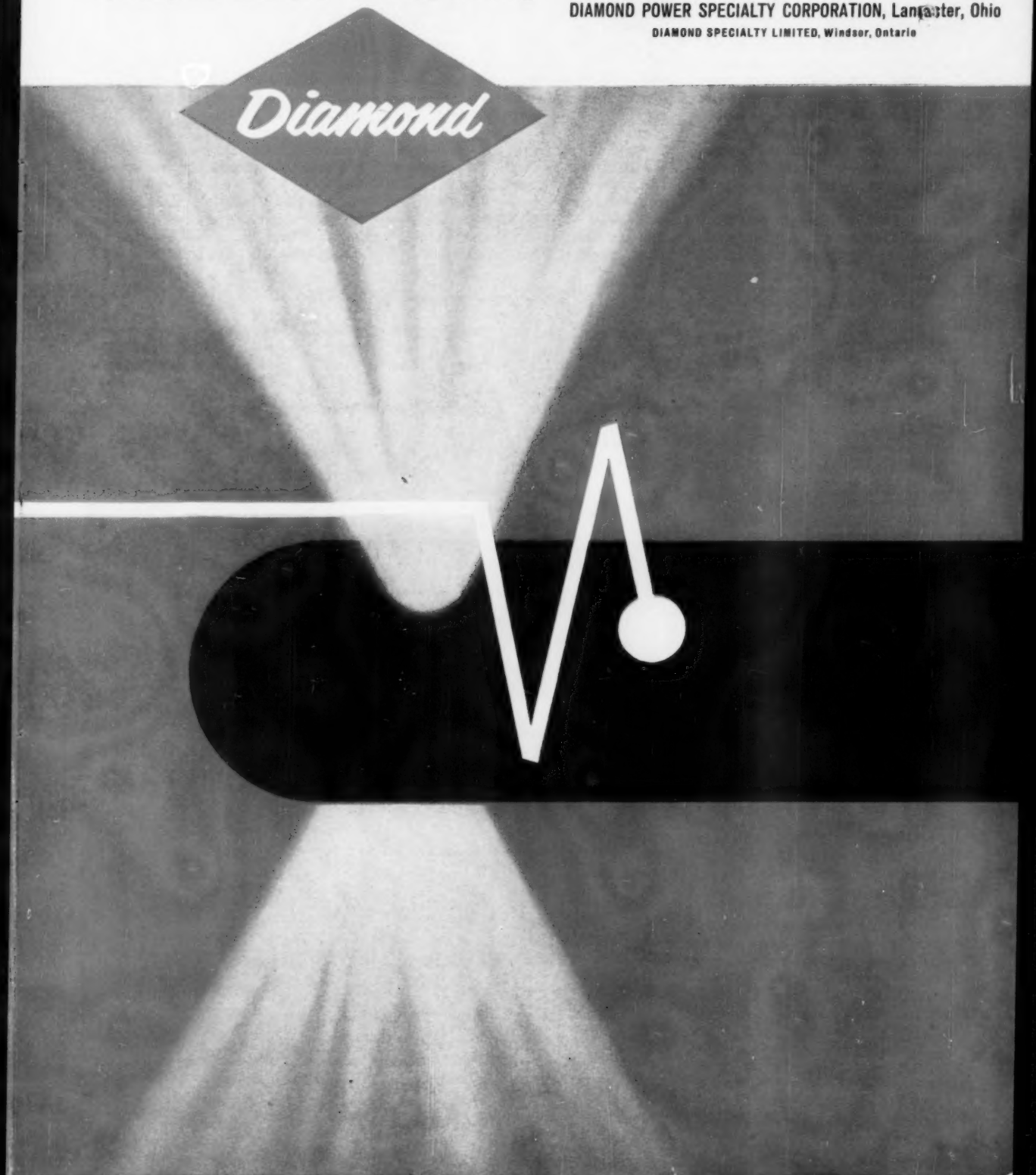
Monitormatic is an automatic method of maintaining constant furnace cleanliness and heat absorption. It responds automatically to changing boiler conditions and eliminates indiscriminate, unnecessary or insufficient blowing. Savings are realized through optimum use of blowing medium, minimized soot blower maintenance, less compressor maintenance if air is used as blowing medium, and reduced operator time. It also automatically adjusts the cleaning system to fuel changes.

Monitormatic is readily and economically applicable to new or many existing Diamond Selectromatic Systems; is another example of why "Diamond Developed" means more economical power generation.

At your request, our Engineers will be pleased to evaluate the application of Monitormatic to your specific system. Call, write or wire for complete information.

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

DIAMOND SPECIALTY LIMITED, Windsor, Ontario



HELPFUL WATER CONDITIONING DATA FROM BETZ

HOW TO PREVENT BOILER

Troubled with boiler scale? A modern scientific approach will eliminate the problem.

THE FORMATION of scale and sludge deposits on boiler heating surfaces is the most serious problem encountered in steam generating equipment. Blistered boiler tubes and tube failures cause boiler outage and loss in production. In extreme cases, complete shut-down of an entire plant can result.

Through the years, industrial plants have found it more economical to generate steam at higher and higher pressures. At the same time, heat transfer rates have increased to aggravate further the problem of scale and deposit formation. Water treatment technology has kept abreast of these increasing demands by developing more effective external and internal treatment methods.

Softening Process	Residual Hardness, ppm
Cold Lime-Soda	30-50
Hot Lime-Soda	15-25
Hot Lime-Zeolite	0-2
Zeolite	0-2
Sodium-Hydrogen Zeolite	0-2
Demineralizers	0-0.5

Figure 1

Figure 1 lists the more common external treatment methods that are employed and the range of residual hardness that usually results. The selection of the method of external treatment is governed by the operating pressure, water characteristics, economics and other factors. Obviously, the higher the operating pressure the more complete must be the job of external conditioning. However, no system of external treatment is in itself adequate protection against boiler scale without the use of supplementary internal chemical treatment of the boiler water. Even the small amounts of hardness present in the effluent of zeolite softeners will produce troublesome deposits.

Mechanism of Scale Formation

Basically, scale formation occurs because the solubility of the scale forming salts decreases as temperature increases. Consequently, the higher the temperature (and pressure) of boiler operation, the more insoluble become the scale forming salts. The chief mechanism of scale formation is the result of crystallization of the scale forming salts from the thin, viscous film of boiler water adjacent to the heating surface where the bubbles of steam originate. The generation of steam bubbles produced by vaporization of the water film causes the dissolved substances in the film to concentrate. Consequently, the solubility of the scale forming salts is first exceeded in this thin film rather than in the main body of the boiler water. The salts with the least solubility will crystallize out first and scale will form on the tube surfaces even when the solubility of the scale forming salts is not exceeded in the boiler water proper.

The calcium and magnesium salts are primarily responsible for scale deposits. With untreated boiler water calcium silicate, calcium sulfate and calcium carbonate will crystallize on the tube surfaces as a hard adherent scale. Magnesium salts deposit primarily as magnesium silicate and magnesium hydroxide.

Prevention of Scale

Prevention of the crystallization of scale-forming salts from the thin film adjacent to the heat transfer surface is accomplished by precipitating the calcium and magnesium salts in the main body of the boiler water in their least soluble form. As a result, the concentration of calcium and magnesium in the film will be negligible. To accomplish these results, calcium is precipitated as the phosphate and magnesium as the hydroxide and/or silicate. These precipitates can settle and bake on the heat transfer surfaces in the

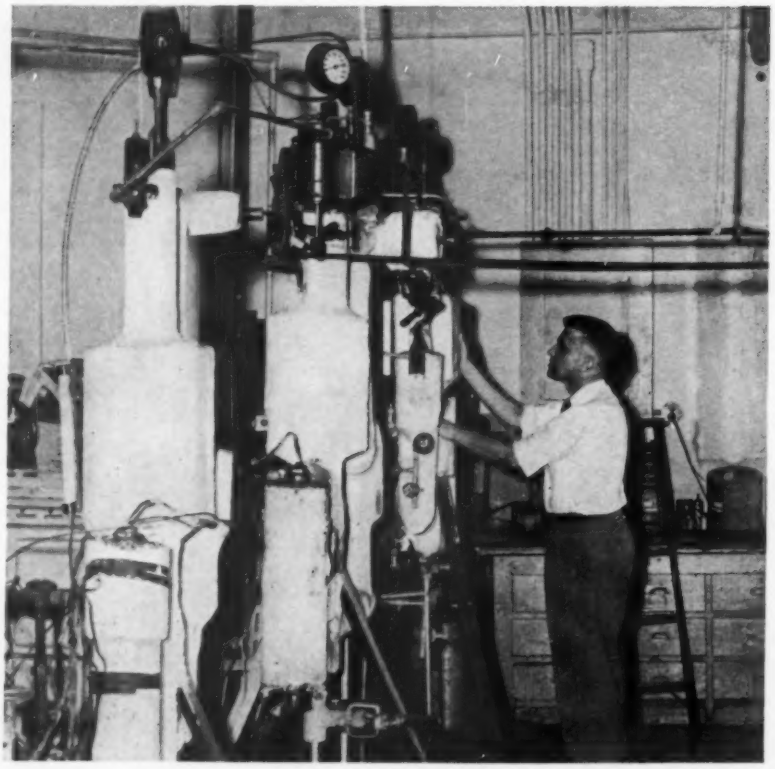
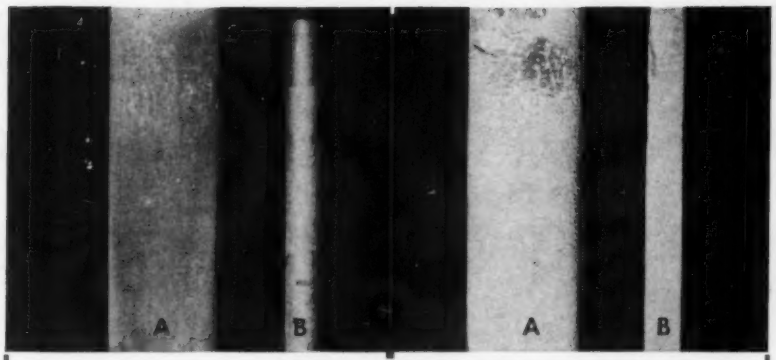


Figure 2—Experimental boilers.



Deposit, grams per sq ft.			
With Sludge Conditioner		Without Sludge Conditioner	
A	B	A	B
0.03	0.12	1.20	5.80

Heat transfer A=28,000 Btu/sq ft/hr; B=180,000 Btu/sq ft/hr

Figure 3

DEPOSITS

form of objectionable deposits, unless they are maintained in a dispersed form as a fluid, non-adherent sludge. Accordingly, further conditioning of these precipitates by organic dispersing agents serves to convert them to a sludge that can be removed by boiler blowdown.

Organic Sludge Conditioners

Starches, tannins, lignins, colloids and other organic agents possess to a varying degree the ability to maintain calcium and magnesium precipitates dispersed in the form of sludge. The ability of various organic agents to accomplish sludge conditioning has been the subject of extensive research. At Betz Laboratories, specially designed experimental boilers such as those shown in Figure 2, are used to develop the most stable and effective sludge conditioning agents available.

These experimental boilers are equipped with feed systems, water level control, blowdown and the safety devices necessary for continuous, automatic operation. The heat input is accomplished by electrical heating elements which serve as the scaling surfaces and have heat transfer rates ranging between 28,000 to 180,000 Btu per square ft. per hour. Figure 3 shows the low and high heat transfer scaling surfaces from a duplicate experiment with and without the use of an organic sludge conditioning agent. The effectiveness of the organic sludge conditioning agent is readily evident.

Other Deposits

Another source of concern is silica. Complex silica deposits, which may or may not include calcium and magnesium in their structure can occur in boilers operating at high pressures and at high heat transfer rates. The silica tolerances for various boiler operating pressures have been well established for prevention of boiler scale and for prevention of silica vaporization with the steam.

Blowdown can be used to control silica concentrations to the proper tolerance levels. When excessive blowdown is required, external silica removal processes should be employed to restrict boiler water silica concentrations within established limits.

The concern for silica is not always because it is too high. In some cases silica can be too low. This situation occurs primarily with waters that contain high magnesium concentrations and low silica values. In these special cases magnesium will tend to precipitate as magnesium phosphate which produces a sticky sludge. Precipitation in this form is aggravated when the feedwater enters in a region of low alkalinity and poor circulation. Under these conditions, increasing the silica content of the feedwater to avoid magnesium phosphate precipitation will prove helpful. However, this practice must be applied within the normal silica tolerances established for the boiler operating pressure. Other factors that must be considered are increased boiler water alkalinity, the use of special organic sludge condition agents and better mixing of the feedwater.

Iron Oxide Deposits

Deposits consisting predominantly of iron oxide are frequently found in boilers operating with very pure feedwater. In such plants, the makeup water requirements are usually low. The usual sludge forming calcium and magnesium salts may amount to less than 5% of the boiler deposit. The origin of such deposits can usually be traced to corrosion external to the boiler. Corrosion of iron or steel in the condensate or preboiler system will permit substantial amounts of dissolved iron to enter the boiler where precipitation will occur as a result of the higher temperature and alkalinity conditions of the boiler water. Prevention of iron oxide deposits originating from corrosion external to the boiler can most effectively be controlled by eliminating the condensate corrosion problem. The materials most commonly employed for this purpose are the neutralizing or filming amines. Where carbon dioxide concentrations are low and dissolved oxygen negligible the neutralizing amines will prove effective and economical. Where carbon-dioxide concentrations are high the use of the filming amines will prove more effective and economical.

Iron oxide deposits originating from attack of the boiler metal can also result. One special case of such attack occurs from steam blanketing. The water and steam oxidize the hot steel to black magnetic oxide at hot spots in the boiler. These problems are associated with extreme heat input and faulty or low circulation and usually lead to tube failures.

Betz research has produced the products and know-how to handle all phases of your boiler water conditioning problems effectively and economically. If you would like additional information regarding Betz service at your plant, we will be happy to have you write us. Why not do it *today?*

BETZ LABORATORIES, INC.

PHILADELPHIA 24, PENNSYLVANIA

■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

Planning to Burn Gas,

You can fire *ANY ONE* or *ALL THREE*

Inside the Turbo Furnace at Sterlington Steam Electric Station of Louisiana Power and Light Co. Overall width 54'—7¼", depth 24'—0-⅜". No. 1 firebrick rubble covers the furnace floor. Twenty Riley Directional Flame Burners are arranged for opposed firing on front and rear walls. Burners are shop fabricated assemblies. Burner close-up shows directional vanes, two

The Riley TURBO FURNACE unit is one of the major furnace design advances in recent years for the more efficient utilization of fuels. It is known as a multifuel unit primarily because of its ability to produce similar furnace exit gas temperatures with gas, oil, coal or other solid fuels. This phenomenum is due to the fact that natural gas, which ordinarily burns with a non-luminous flame, burns in a TURBO FURNACE with a luminous flame similar to oil and coal. In a TURBO FURNACE, fuels are burned with extremely high turbulence at the furnace bottom.

Much of the unusual combustion efficiency is due to opposed firing with Riley Directional Flame Burners specially designed for firing multiple fuels singly or in combination. These fuels may be pulverized coal, oil, gas, or other special solid fuels such as fluid coke or lignite.

Water Cooled Burner

The Riley Directional Flame Burner is designed for opposed firing on one level. Each Riley Directional Flame Burner is installed as a unit complete with water cooling tubes which are welded to the waterwall circulation system. The waterwall tube arrangement provides maximum cooling of directional vanes, nozzles and other burner parts and reduces to a minimum the possibility of slag adhesion when coal is being burned. No burner refractories are required.

Coal Burning

Two or three burner nozzles per burner are provided when coal or other solid fuels are to be burned. In this way the coal streams are more evenly distributed across the furnace to assure good mixing of fuel and air in the furnace.

Oil Firing

A retractable type oil gun is inserted thru the center slot so as to provide complete mixing of the spray with the air stream. Oil can be burned with either steam or mechanical atomizing equipment.

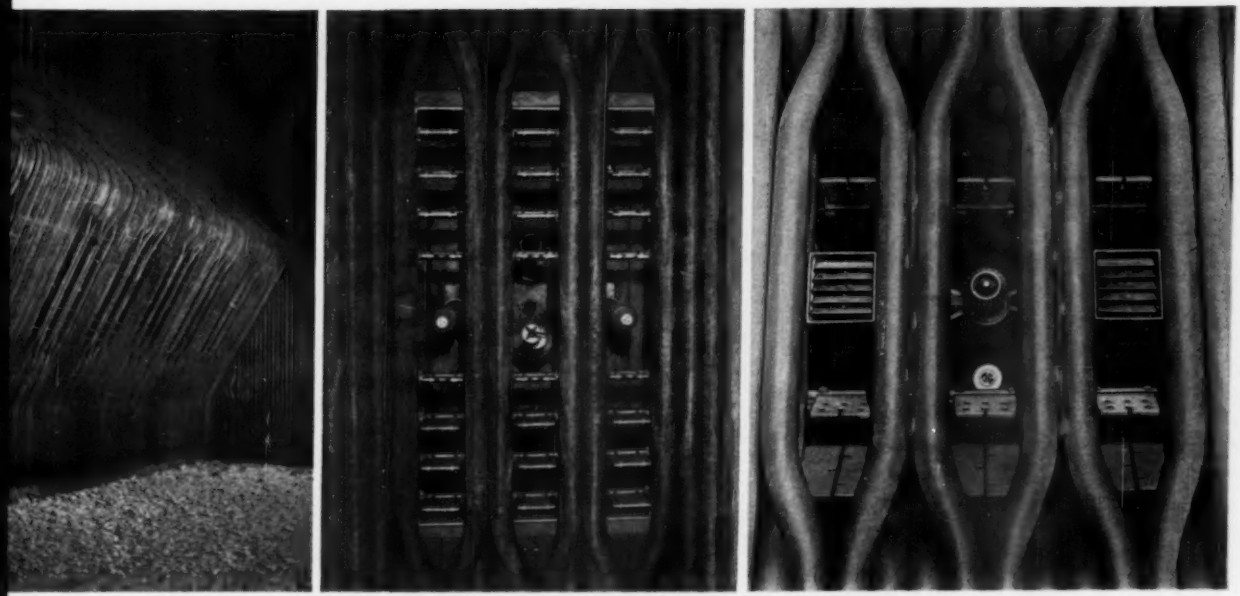
Gas Firing

Gas is fired thru guns of high alloy stainless steel. High capacity burners have a gun in each side slot. Gas guns can be installed for mechanical retraction.

A RILEY TURBO FURNACE GIVES YOU THESE MONEY-SAVING ADVANTAGES

- **The ability to fire multiple fuels: gas, oil and a wide range of solid fuels**
- **A low cost and quick conversion to solid fuels with initial gas/oil firing**
- **Higher heat release with lower overall structure**
- **Minimum Superheater/Reheater metal temperature variations across full width of furnace.**
- **No restrictions on furnace widths.**
- **One level burner operation.**

Oil or Coal?
in a RILEY TURBO FURNACE



gas guns, gas electric ignitor, observation port. Burner can easily be converted to oil and coal firing. At far right is a Directional Flame Turbo Furnace Burner for firing coal, oil, and gas. Note the complete absence of burner refractory.

Directional Vanes

Each slot is provided with directional vanes to project secondary air into the furnace so as to secure the desired placement of flame for most effective combustion. The vanes above the burner centerline and those below each have separate controls. Vanes are made of high heat resisting alloy.

Burner Shut-Off

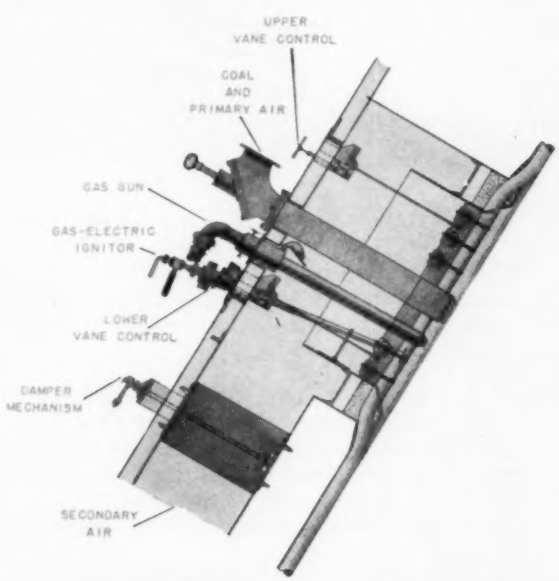
Each burner has a separate secondary air shut-off damper which can be locally or remotely controlled.

Riley Gas-Electric Ignitors

Riley Gas-Electric Ignitors are available with Riley Directional Flame Burners.

Pressurized and Non-Pressurized Operation

Riley Directional Flame Burners are designed so that they can be used either with pressurized or non-pressurized furnaces.



For the complete description of the Riley TURBO FURNACE write:

RILEY STOKER CORPORATION, Worcester, Mass.

SALES OFFICES

Boston, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

For more data circle 511 on Post Card

Consult this expert on plant location

Build Your Plant Near An Unlimited Fuel Supply

The Squirrel is a sound planner. He builds his nest near Hickories and Oaks so that he will have a plentiful supply of nuts and acorns . . . *"fuel" for the Squirrel!*

Take a tip from the Squirrel. Locate your new plant near a large reservoir of fuel . . . Peabody's two-billion-ton coal reserves. Since shipping charges are a big part of your fuel costs, this close proximity to a dependable coal supply is just good business. It assures your Company an economical source of power for now *and* the years ahead, and protects your capital investment in buildings and equipment.

Let Peabody help you select *your* new plant site—it's an important part of our service . . . and one that can save your Company *millions!*

Learn more about the location of Peabody's 29 modern mines and river dock loading facilities. Write Industrial Development Division, Department PE.

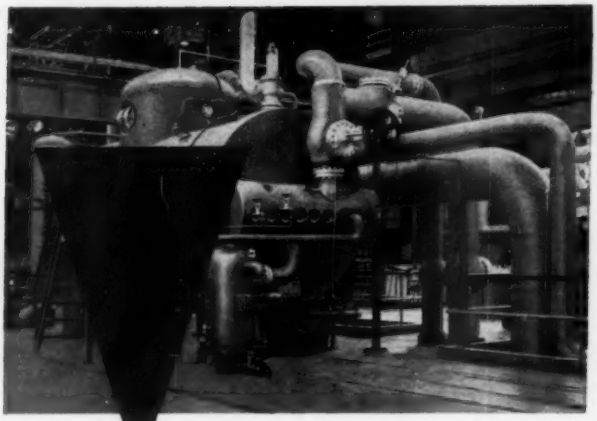
power for progress

PEABODY COAL COMPANY

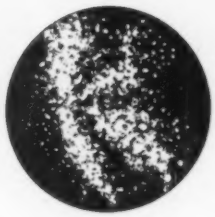
Peabody Plaza • 301 Olive Street • St. Louis 2, Missouri

Offices in: Chicago, Columbus, Des Moines, Detroit, Indianapolis, Kansas City, Louisville, Madison, Wis., Memphis, Minneapolis

For more data circle 512 on Post Card



WHEN INDUSTRY NEEDS WATER



PURER THAN THE DRIVEN SNOW

Yuba Evaporators are achieving new record high purities

In power, processing, marine or any industry that needs high purity water in volume, Yuba evaporators are recognized as the finest equipment available today. There are good reasons why. Recent tests by Consolidated Edison Company of New York show that purities better than 0.004 PPM total solids are achieved – purities "heretofore unknown." Heart of the Yuba evaporator is the patented improved bubble tray design. Yuba evaporators have reached their present peak because of continuous refinement of design, engineering and manufacturing. And Yuba's mechanical vapor purifier has also been found to be the most efficient of its type within the limits of mechanical purifier design.

Bubble tray or mechanical evaporators, Yuba designs are the most flexible in the industry. They can be installed vertically or horizontally—in a wide capacity range – depending on the industry need or basic plant design. Whatever your high purity water need, remember Yuba for the finest in evaporators. Write today for the complete story of tests on Yuba equipment – Bulletin YHT 101.

Other Yuba products for steam power plants include Condensers, Feedwater Heaters, Expansion Joints, Heaters, Tanks, Cranes, Structural Steel and scores of other items.

YUBA

specialists in power plant equipment

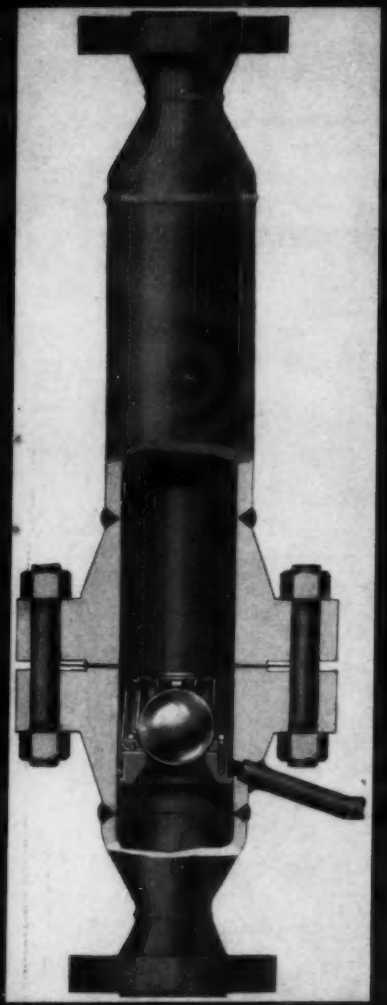
YUBA HEAT TRANSFER DIVISION

YUBA CONSOLIDATED INDUSTRIES, INC.

SALES OFFICES IN PRINCIPAL CITIES

For more data circle 513 on Post Card

H. J. Heinz relies on Copes-Vulcan reducing and desuperheating station to handle big changes in steam demand



(Far left) **Chart on left side of panel** shows wide load changes. Chart on right indicates exacting pressure and temperature control. Station takes boiler steam at 600 psig and 750 degrees F. and delivers it to process at 110 psig and 360 degrees F.

(Cutaway at left) **A weighted steel ball** controls orifice opening, speeds intimate mixing of cooling-water and steam. No atomizing steam, spray nozzle, or glands required. Write for Bulletin 1037.

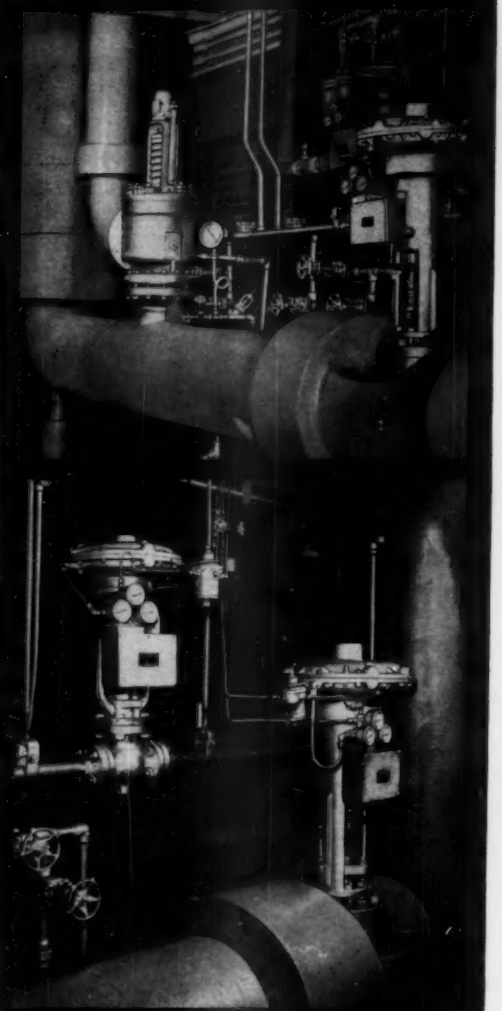
(Upper right) **The 8-inch, 300-pound pressure desuperheater** is installed in the insulated vertical run of steam piping at the far left. The cooling-water control valve is behind the pressure reducing valve in the right foreground.

Fast acting valves assure rigid control

Cooling water flow for the desuperheater is controlled by a 1-inch, 300-pound standard Type CV-D diaphragm valve (left) actuated by a temperature controller.

The 600-pound standard Type CV-D reducing valve (right) has a 4-inch inlet and 8-inch outlet to take care of steam expansion at reduced pressure. Its positioner assures accurate control modulation.

Copes-Vulcan diaphragm type valves can be direct or reverse acting. Piston types are also available for high duty service, assure maximum power with precise positioning. Write for Bulletin 1027.



Working with flow rates that vary from 0 to 70,000 pounds per hour, this Copes-Vulcan reducing and desuperheating station holds process steam to plus-or-minus 4 psig and plus-or-minus 5 degrees F. with only 16 degrees F. superheat. Wide fluctuations in steam requirements often occur extremely rapidly at the H. J. Heinz plant in Pittsburgh. On a typical day, the load increased from 0 to 47,000 pounds per hour within 15 minutes, then dropped back to 5,000 pounds per hour in even less time.

Made up of a Copes-Vulcan Variable-Orifice desuperheater and diaphragm operated Type CV-D valve, this type of station represents a new approach in process steam control. Since its installation over a year ago, the station has maintained an outstanding record for continuous accuracy.

Whatever your operating conditions, Copes-Vulcan has the desuperheating station for controlling your reduced steam temperatures. Besides the Variable-Orifice type, the line includes a Steam Assist type and a Carburetor type. Write for details.

Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division

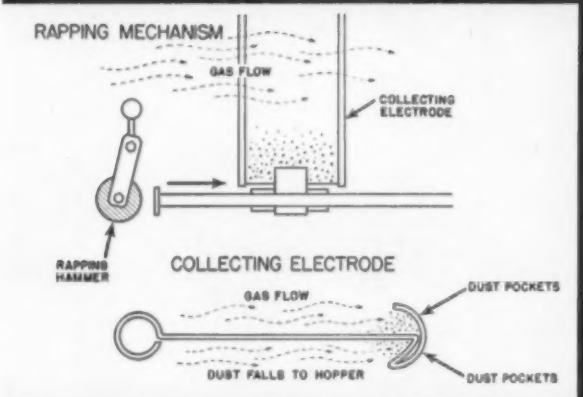
BLAW-KNOX

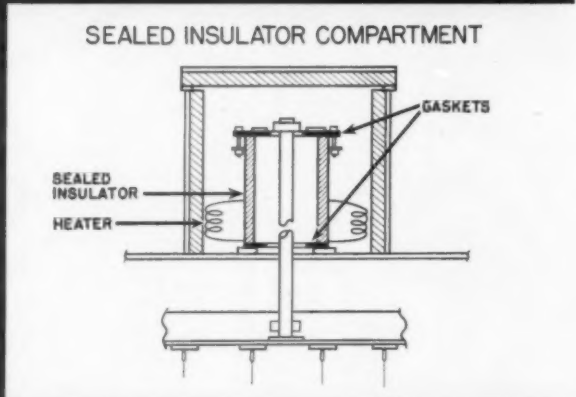
For more data circle 514 on Post Card

SOME PLAIN FACTS

ABOUT SUPERIOR PRECIPITATOR PERFORMANCE

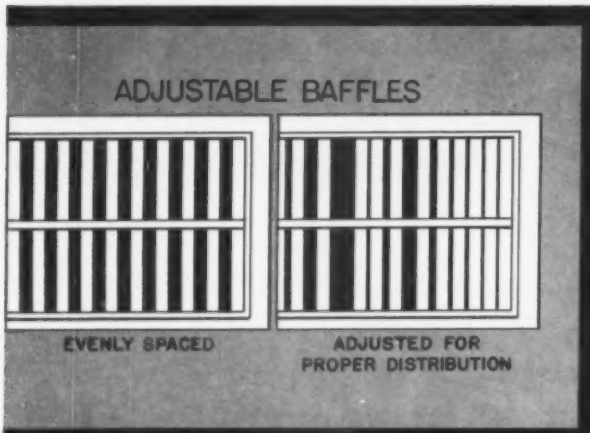
Buell Precipitators are designed and constructed for rugged service and superior performance. Frills and internal frim-fram of a doubtful value are eliminated in favor of strength and simplicity. The casing, outside supports, and internal parts are of rugged construction; and the four-point suspension of emitting electrodes ensures the greatest stability. Here are just a few of the outstanding features of Buell Precipitators.





Effective Continuous Cycle Rapping—Yes, it's mechanical. A simple, rugged system free of complicated gadgets; assures positive dust shearing action. Each row of electrodes is rapped separately—in the direction of the gas flow—on a continuous cycle. Dust is sheared off, drops in an agglomerated mass and pockets on electrodes minimize reentrainment.

Sealed Insulators Improves Operation—High voltage quartz support insulators are completely sealed; prevents gas and dust leaking into insulator compartment and outside air leaking into precipitator. There is no need for costly ventilating systems. Thermostatically controlled electric heaters insure start-up without danger of moisture condensation and insulator breakdown.



Uniform Distribution of Gas Flow—Field adjustment capability is vital. Buell's adjustable baffle permits final positioning after field measurement of actual flow distribution . . . because gas flow patterns are not entirely predictable. The Buell distribution system assures equal gas loading through the precipitator; eliminates ineffective "dead" areas around passages and prevents "sneak-by."

Buell Spiralectrodes cut maintenance to a minimum. Buell's record stands at less than 1% replacement in this key area. Self-tensioned spiralectrodes eliminate vibration and "off-center" swaying, often prevalent with weight-tensioned wires. They're structurally fixed and once installed stay in alignment. The spiralectrode provides greater emission than straight wires.

Buell precipitators are simple and effective. They're designed for continuous service. You'll be glad you turned to Buell when you experience superior performance and low maintenance. Detailed literature describing all features is available.

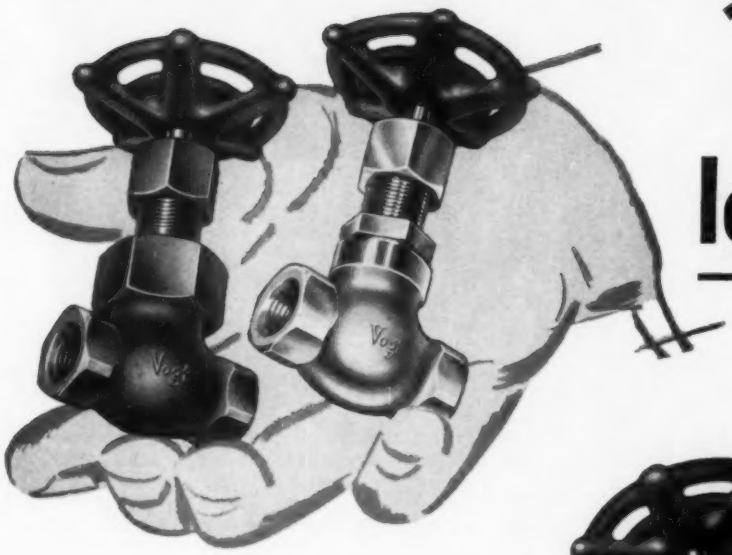
buell Norblo

The Buell Engineering Co., Inc., Dept. 52-C, 123 William Street, New York 38, N. Y. Northern Blower Division, 6434 Barberton Avenue., Cleveland, Ohio.
■Electric Precipitators ■Cyclones ■Bag Collectors ■Combination Systems ■Fans ■Classifiers.

For more data circle 515 on Post Card

New higher quality

New lower price



Enlarged production facilities combined with improved manufacturing techniques enable Vogt to pass on the effected savings to our customers.

Service proved — these valves have always been a standard of quality for meter and gauge line service. You no longer need to compromise for less because of price! Send for Folder GP-9 giving specifications and engineering data on both globe and angle types, forged from stainless or carbon steel for every meter and gauge line service.

Address Dept. 24A-FPE

METER & GAUGE LINE

Vogt

VALVES

HENRY VOGT MACHINE CO.
Louisville, Kentucky
SALES OFFICES: Camden, N. J., Charleston, W.Va., Chicago, Cleveland, Dallas, Los Angeles, New York, St. Louis.

For more data circle 516 on Post Card

Now... a completely self-cased, MODULAR BOILER

C-E's NEW

DESIGN HIGHLIGHTS OF THE VU-60

Modular construction makes it possible to assemble custom designs from standardized components.

Boiler can be proportioned for best combustion, heat absorption and gas flow even when space conditions are limited or difficult.

Completely self-cased, the VU-60 is an all-welded gas-tight and pressure-tight envelope of finned furnace and boiler tubes. This results in less non-working weight per pound of steam capacity.

No external ductwork. The bottom of the boiler is a plenum chamber which allows air to flow direct from the air heater to the burner windbox.

Number of field-welded pressure parts is greatly reduced.

Cross flow baffling and symmetrical boiler bank mean low draft loss, no sluggish gas flow in any pass.

Requires only a simple, reinforced concrete slab. No conventional roller supports required.

Paneled construction cuts erection time.

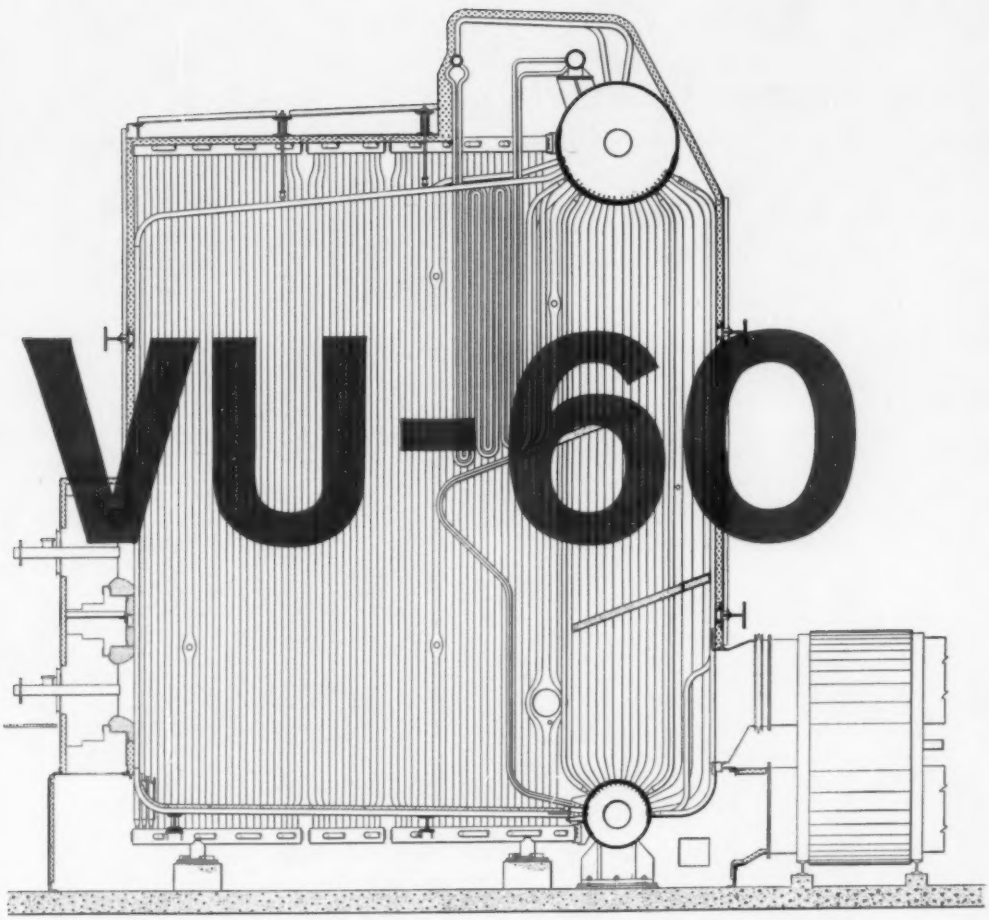
No air heater supporting steel is required.

For pressurized or induced draft firing. When pressurized, unit does not require induced draft fan.

VU-60 SPECIFICATIONS

Capacities:	100,000 to 250,000 lb per hr
Design pressures:	250, 500, 750, 1000 psi
Steam temperatures:	To 900 F
Fuels:	Oil and/or gas
Firing:	Horizontal (front wall) or tangential
Size increments:	Depth — twelve Width — eight Height — three
Steam drum sizes:	Four

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



The VU-60 Boiler is a new and logical extension of C-E's service-proved VU series. Like all VU units, it is completely integrated, symmetrical in design, uncluttered and uncomplicated. Based on a standardized modular concept, it offers greater flexibility, yet stays within the bounds of solid and proven practice.

The VU-60 is a functional boiler. Completely self-cased, the exterior walls of this unit (furnace and boiler) are composed of finned tubes, shop welded into panels. The fins between panels are field welded to form a gas- and pressure-tight structure. Insulation is applied directly to the outside of these walls and is covered by pre-formed, field installed metal lagging. Thus non-working weight and bulk is reduced to a minimum.

The VU-60 is economical, it is dependable, it is accessible. It is easy to install and will meet your most exacting steam needs. Why not write for further information, or, if you prefer, contact the C-E office nearest you.

COMBUSTION C-E ENGINEERING

General Offices: Windsor, Conn. • New York Offices: 200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd. C-300

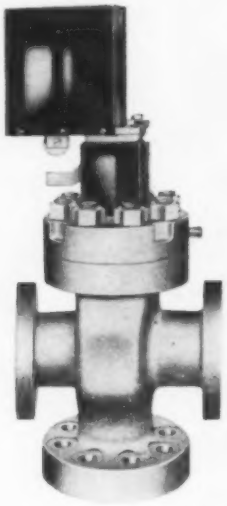
PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 517 on Post Card

power

CONSOLIDATED ELECTROMATIC® RELIEF VALVES

conserve power, increase efficiency in H-P, H-T boiler operation



Consolidated Electromatic Relief Valve. Sizes 2½" to 14". Pressures to 3000 psi. Temperatures to 1120° F. Double outlet.

conserved

Automatic, electrically-actuated Consolidated Electromatic Relief Valves assure more accurately balanced boiler operation at peak loads and more uniform line pressure.

The Electromatic protects the superheater at start-up. It may be actuated manually at any pressure to provide greater steam flow during start-up and to minimize the possibility of burning the superheater tubes due to trapped condensate or hot spots. Safety valve seats and turbine components are protected by using the Electromatic to purge scale, weld splatter, and other foreign matter.

With the Electromatic set to open before any of the safety valves, its 1% blowdown handles line pressure surges without lowering the operating pressure. Power is conserved and boiler efficiency increased.

You can also reduce maintenance by setting the Electromatic to operate before the safety valves. It becomes the working valve and since a gate valve can be installed under the Electromatic, it can be isolated in case of damage and repaired while the unit is on the line.

Conserve power and increase the efficiency of your steam generating plant. Get complete details about all the elements in Consolidated Electromatic Relief Valve System.

Write for Bulletin 720.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

CONSOLIDATED SAFETY VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division • Stratford, Connecticut

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland

For more data circle 518 on Post Card

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½′ x 11′ x 8′ PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

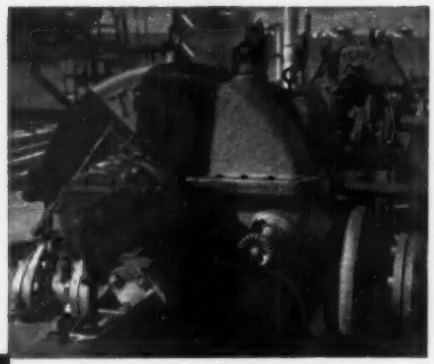
THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

For more data circle 519 on Post Card

TERRY SOLID-WHEEL TURBINE

spells service continuity for mechanical drives



Terry solid-wheel turbine with cover removed to show internal construction.

For mechanical-drive applications, such as these, you will never find the equal of Terry solid-wheel turbines for built-in dependability. They are *designed* for trouble-free operation under the toughest service requirements.

The wheel, for example, is a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out. The blades can't foul since they are double-rim protected...with one-inch clearances at either side.

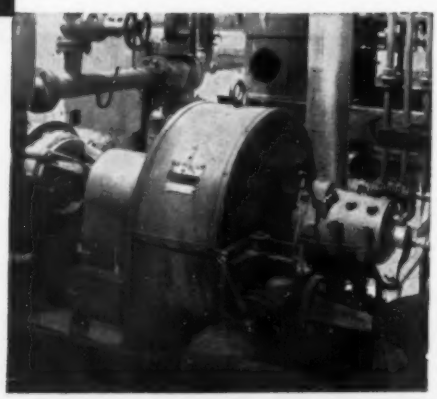
Any blade wear, which might occur after years of service, is of little consequence. As the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

Specify Terry solid-wheel turbines for your next mechanical drives. They are available in capacities from 5 to 2,000 hp., speeds up to 10,000 rpm. Vertical turbines are built in sizes from 5 to 300 hp.

For full information about these reliable turbines, send for bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



TT-1216

For more data circle 520 on Post Card

Current Catalogs

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 93 and 94.

Mechanical Power Transmission

101 Automatic Clutches — Featured by Formsprag Co. in 42-pp Catalog 142 are automatic centrifugal clutches and clutch couplings designed for industrial power transmission applications. Covers basic functions, principal advantages and performance characteristics, and includes tables, charts and graphs covering horsepower ratings, service factors, typical mounting arrangements.

102 Locking, Positioning Device — Catalog RL-101, 22 pp, Formsprag Co., describes Rev-Lok dual torque locking and positioning device. Presents a concise review of this two-directional drive unit, which can be mounted to transmit driving torque, over-run, backstop, prevent feedback or function in a torque sensing capacity. Components and construction, operating principles, design advantages, functional versatility, installation and maintenance are discussed. Also treated are break-away torque, overhauling loads, thrustloads, torsional wind-up, radial loads. Eight applications are depicted.

103 Self Lubricating Bearings — Eighteen-pp Stock List S-60 of Amplex Div., Chrysler Corp., details 1066 standard sizes of self-lubricating bronze bearings. Includes oilite in cored, bar, plate stock, discs, strips and Super Oilite in cored and bar stock. A section is devoted to engineering data with pictured demonstrations of the self-lubricating qualities of the bearings.

104 Timing-Belt Drives — Detailed information on timing-belt drives for mechanical power transmission for load capacities from fractional to 600 hp and for belt speeds to 16,000 fpm is presented by T. B. Wood's Sons Co. in 80-pp Catalog 19103. Selection tables are designed to provide needed information with minimum of calculation, including determination of driven pulley and belt pitch length when speed ratio and driver pulley are known.

105 Universal Drive Tensioner — Featured in this product bulletin of Brewer Machine & Gear Co. is a universal drive tensioner designed to provide controlled tensioning for smoothness and efficiency of operation. Mounting illustrations are included in the bulletin.

Pumps, Pumping

106 Rotary Gear Pumps — Described by Northern Ordnance Inc. in Bulletin 43 are rotary gear pumps individually designed for specific applications in handling materials with viscosity ratings from 300,000 to 30 ssu. Dimensional and ratings data included.

107 For Quiet Pumping — Details on a quiet running motor-pump for applications where a low noise level is required are given by Ingersoll-Rand Co. in Form 70287. Includes pump selection chart and data on approximate dimensions.

108 Pumps for Cooling Towers — Provided by Bell & Gossett Co. in 8-pp Bulletin CT-360 is a six-step guide for planning pump and piping requirements of cooling tower installations. Covers determining amount of water to be circulated to tower; making layout of piping system; determining static head and pressure drop; pump selection; pipe sizing; checking of pump and pipe sizes. Charts show capacities of pumps.

109 Metering Pump — How to overcome losses due to stuffing box leakage is told by Process Equipment Div., Lapp Insulator Co., in this product bulletin. Chart illustrates daily and yearly leakage costs based on value of liquid metered. Data on metering units with leak-proof design is included.

Piping, Valves and Fittings

110 Glassed-Metal Pipe — Applications of glassed-metal pipe, valves and fittings designed to prevent corrosion and protect product purity are described in 16-pp Bulletin 987 by Pfaudler Permutit Inc. Cutaway drawings and detailed specification and dimensions are included.

111 Sound Absorbing Pipe — Bulletin 866 covers SoundZorber wire-reinforced flexible rubber pipe available from General Rubber Co. This pipe is designed to reduce noise and vibration disturbance in pipe line installations. Construction features and operating characteristics are discussed and sizes given. Also provided is comparison of acoustical impedances of this and other types of pipe.

112 Overhead Pipe Systems — Plasti-Clad prefabricated insulated pipe systems for overhead lines are described as to construction and application in 6-pp illustrated Form PC-11 of Ric-wiL Inc. Includes data on suggested pole spacing.

113 Pinch Valves — Construction features and advantages of Massco-Grigsby pinch valves are explained and illustrated in 14-pp Catalog 609 by Mine and Smelter Supply Co. Provides sleeve service recommendations and specifications and closing mechanism specifications for manual, motorized and hydraulic types. Also introduces Hydral-60, a pinch valve system of one or more of the hydraulically operated valves with individual control valves.

114 Ball Valve — Bulletin DH-38 contains detailed information on a forged naval bronze ball valve with "auto-mating" seats introduced by R-P & C Valve Div., American Chain & Cable Co., Inc. Cross-section view of valve is keyed to a material and dimensions specification table.

115 Compact Valves — Compact screwed-end plug valves for instrument and process piping are described by Continental Mfg. Co. in Bulletin D-1. Photos and exploded views of valve's components are included along with dimension tables.

116 Corrosion-Resistant Valves — Illustrated and described in 16-pp Bulletin 7 is Alloy Steel Products Co.'s line of corrosion-resistant valves, including gate, globe, angle, Y, check, flush bottom tank, and sampling valves and accessories. Includes engineering specifications and list of alloy materials, with chemical composition ranges and mechanical properties.

117 Safety Shutoff Valves — Featured in 12-pp Supplemental Bulletin 22, released by North American Mfg. Co. are safety shutoff valves and supervising gas cocks for two-way plant protection. Capacity tables, dimensions and general specifications are included.

118 Cast Steel Valves — High pressure, high-temperature cast steel valves are described in Walworth Co.'s Pressure-Seal bulletin 6 pp. Dimensional data and material specifications are included.

119 Valve Sizing Charts — Bulletin JSC-1 shows how to size sliding gate regulators and control valves of OPW-Jordan Corp. Simplified charts cover steam, liquid and gas service and cross-reference method of compiling make sliderules and formulas unnecessary. Technical data (applying to all makes of valves) tells how to adjust sizing for variations in pressure, temperature, viscosity or specific gravity.

120 Rotary Joints — Catalog 310-B, released by Barco Mfg. Co., describes rotary joints which require no lubrication, work for single flow or syphon steam service, and handle steam, water, air, oil or gas. Working pressure ratings, dimensions and installation suggestions included.

Waste Handling

121 Rugged Drainline — Sixteen-pp Bulletin 30 gives detailed information on Pyrex brand "double tough" drainline of Corning Glass Works. Contains product and property data and lists advantages of the corrosion-resistant glass system for disposal of chemical wastes. Also gives details on available fittings. Photos, schematic drawings and charts included.

122 Rectangular Collectors — Straightline sludge collectors are described by Link-Belt Co. in 28-pp Book 2746. Data provided enables selection of proper size tank for both Types H and L collectors. New mechanical details and arrangement drawings of various designs for both are illustrated. "Ten States Standards for Sewage Works" specifications for sedimentation tanks are reprinted in entirety. Also presented are illustrations of Uniflow and preaeration settling tanks to which Straightline collectors are adaptable.

123 Incinerator Types — Presented briefly in this bulletin of Turnkey Engineering Co., Inc., are incinerators for combustible waste disposal; cyclones and bag houses for by-product collection and recovery; water washers for cleaning of exhaust and make-up air; after burners for elimination of organic by-products. Tells steps required in selecting an incinerator

and provides data on waste classification estimated waste production rates.

Instruments and Controls

124 Advanced Potentiometer — Highlights of the ElectroniK potentiometer are presented in this 24-pp bulletin by Minneapolis-Honeywell Regulator Co. Stresses performance advantages afforded by the Stranducer rebalancing element, versatility possible with modular construction and plug-in interchangeable components, and long range economy as well as lower initial cost. Three basic models — strip chart, circular chart, and circular scale — are illustrated. Also described and pictured are display, drive and case modules.

125 Monitoring Systems — In this 8-pp booklet, Lynch Communication Systems, Inc., describes a high speed, continuous electronic system designed to monitor any condition representable by an electrical contact closure. Applications include circuit breakers, switches, sensing devices etc. Bulletin discusses system synchronization, construction features. Includes handy glossary of monitoring terminology.

126 Analog Computer — Dynamic storage analog computer for determining complex chemical equilibrium conditions and composition described in Computer Systems, Inc. Report Form 80-105-008. Tells how computer uses this criterion to establish equilibrium conditions as a function of temperature.

127 Multiple Recorder — The K-Logger, a multiple recorder-annunciator capable of recording 10 to 400 variables, is introduced by Keinath Instrument Co. in this 6-pp color-illustrated bulletin. Explains operation of the unit and shows how a single chart becomes a graphic "panel." A typical chart frame is illustrated in full size.

128 Liquid Meters — Stainless steel liquid meters capable of handling corrosive and non-corrosive liquids are featured in Neptune Meter Co.'s Form 94/10-1. List of corrosive liquids that can be handled.

129 High Pressure Rotameter — Bulletin 131 covers an indicating rotameter designed for pressure to 5000 psig at 200 F. A publication of Brooks Instrument Co., Inc., bulletin incorporates detailed drawings, dimensions and capacity tables along with operation information.

130 Magnetic Flowmeter System — Described in 8-pp Specification 10D-1410B is a low conductivity magnetic flowmeter system. Offered by Fischer & Porter Co., bulletin covers materials of construction, mounting and capacities and includes dimensional drawings and wiring diagrams.

131 Temperature Controls — Differential expansion type temperature controls manufactured by Burling Instrument Co. are illustrated and described in Catalog G-25. Included are specifications for both electric and pneumatic instruments.

132 Steam Temperature Control — Operation and control of high steam temperatures is described in Bailey Meter Co.'s Bulletin 543. Three detailed diagrams explain principle of desuperheater water control and burner tilt and desuperheater water control.

133 Vibration, Strain Meters — Bulletin K-19A describes The Korfund Co.'s line of instruments for measuring, recording and analyzing vibration and strain. Includes photos, data charts and specifications on vibration transducers and exciters, strain gages, load cells and beams and engine monitoring equipment.

134 Valve Operator — Applications and features of Crane Co.'s Converto-Gear Operator designed to fit wide variety of Crane iron and steel gate valves, 2½ in. or smaller, are detailed in Form AD-2441. Dimensional data and installation photos are included.

135 Water Treatment Control — Hydrotrol, automatic water treatment control for cooling water systems, is the subject of this bulletin of Heller Laboratories, Inc. Explains how Hydrotrol works, how it solves water treatment difficulties.

136 Control Linkage — Twelve-pp Brochure P81-5 of Bailey Meter Co. illustrates typical linkage arrangements for fan damper control, stoker speed control, coal feeder gate control and feed pump fluid coupling control. Drive and driven levers are explained with line drawings and charts. Also covered are connecting links, bearings and shafts, cable connectors, and cable and pulley connectors.

137 Instruments, Accessories — Illustrated and described in this 6-pp product bulletin by Barbour Stockwell Instruments, Div. Curtis & Marble Machine Co., are tachometers, adapters, flexible shafts, clutches and gear boxes. Features and advantages are detailed.

138 Charts, Inks — Catalog G-100-6, 26 pp, lists Electronik strip, circular, and Tel-O-Set (pneumatic and electric) charts of Minneapolis-Honeywell Regulator Co. Covers recording inks — general types, Type 130, multipoint recorders, and includes ink selection and maintenance recommendations.

Heating, Ventilating and Air Conditioning

139 Hot Water Converters — Twenty-pp Bulletin 71 of Niagara Weldments Inc. presents NiaWel hot water converters for space heating service. Besides giving specifications covering 114 models in two- and four-pass arrangements, bulletin describes ASME construction of shells and removable U-tube bundles, available metals and alloys for special fabrications. Provides illustrated method for selecting correct size shell and heating surface.

Postage-free cards for ordering catalogs are on page 93. You may also use the cards to order literature mentioned in the ads.

140 Centrifugal Fans — Eight-pp Bulletin DB-2-306 describes Ilg Electric Ventilating Co.'s small direct-connected, belted and portable centrifugal fans. Specifications and dimensional diagrams are included in the bulletin.

141 Power Roof Ventilators — Two basic power roof ventilators of L. J. Wing Mfg. Co. are described in 8-pp illustrated Bulletin PRV-60: straight-through (Wing-Jet) and dome (Wing-Dome) types. Standard and optional features, tables of sizes, dimensions, performance data included.

142 Refrigeration, Air Conditioning — Refrigeration Catalog 103, 16 pp, published by McQuay, Inc., features air conditioning, heating and refrigeration equipment. Pictures, description and tables of commerical refrigeration equipment are included, specifications, capacities and accessories. Rapid selection tables for company's walk-in coolers, freezers and hardening rooms are given.

Electrical

143 Open Motors — Stator insulations and full-protection features of Allis-Chalmers Mfg. Co.'s Super-Seal motors are illustrated and described in 12-pp Bulletin 05-51B9040B. Advantages and performance details are covered and typical applications illustrated.

144 Compact Substation — Features and advantages of Allis-Chalmers Mfg. Co.'s Regu/Tran compact substation are detailed in 6-pp Bulletin 61B9756. Lists unitized components and gives dimensional and specification data.

145 Plug-In Bus Duct — Bulletin XL-765, 32 pp, provides technical data, dimensions, catalog information and layout procedures for a new plug-in bus duct with low voltage drop characteristics and built-in safety features. Also included are dimensional and technical data on X100 bus duct, 100-amp plug-in duct for use as lighting distribution feeder or extended panelboard. Booklet is offered by Bulldog Electric Products Div., I-T-E Circuit Breaker Co.

146 Power Centers — Bulletin GEA-7080 contains 12-pp of information on General Electric Co.'s power control centers engineered and custom-built to customer specifications. Describes application of the control centers where standard motor starters are interlocked and sequenced with specialized control functions for operation of complex industrial processes.

147 Two-High Controller — Design and operating features of the Space-Maker controller are described by Allis-Chalmers Mfg. Co. in 8-pp Bulletin 14B-9739. This lightweight controller is announced as the first two-high, drawout control in the 2000-5000 v range. Discusses lower installation costs, space saving advantages, accessibility, other benefits.

148 Oil Circuit Breakers — Construction and design features of Allis-Chalmers Mfg. Co.'s intermediate outdoor oil circuit breakers are described in 8-pp Bulletin 71B8475. Plan views and dimensions are included.

149 Electro-Magnetic Relays — Comprehensive engineering data on electromagnetic relays is presented in this 16-pp product bulletin by Potter & Brumfield Div., American Machine & Foundry Co. Mounting data and descriptions of wide variety of enclosures is given, as well as information on various terminals.

150 Low Voltage Equipment — Illustrated and described by General Electric Co. in a 92-pp Fall, 1960 Buy Log on low voltage equipment are safety switches, tumbler switches, wireway, circuit breakers and enclosures, panelboards, switchboards, motor control centers, sectional

Continued on page 93

HAGAN NEWSLETTER—MARCH

Behind the panel

HAGAN POWRMAG® MAKES A "SWEET" CONTROL SYSTEM

In sugar refineries, moist sugar is fed to the upper end of a rotary dryer-granulator so that moisture can be removed as the sugar is granulated. The sugar is discharged into dry sugar containers and control must be accurate to avoid caking or burning of the finished product. Hagan PowrMag systems are doing this "sweet" job in two plants of a major refiner. Drying is accomplished by a blast of warm air from a constant speed blower. Setpoint temperature is maintained by varying steam flow to a heat exchanger over which the air flows. Both air temperature and sugar temperature are measured by resistance bulbs, and sugar temperature is maintained by varying the set point of the air temperature controller in accordance with any error signal from the sugar temperature recorder. A total of nine such systems are in operation. (Details on request. Ask for Item P-1.)

TEMPERATURE RISE USED TO PROTECT $125,000 PUMP

Boiler feed pumps for a big utility boiler come high. At one station, generating 1,800,000 pounds of steam per hour, there are three such pumps. When flows through these pumps are low, internal temperature rise increases and the pump can easily be destroyed. Conventional recirculation systems use feedwater flow as a criterion, but this does not provide protection against heating which may occur even though flows are beyond the usual danger point. Hagan systems use temperature difference across the pumps to establish control. Taking a thermocouple signal of about 0.6 mv, the Hagan PowrAmp amplifies the signal, puts it through an electro-pneumatic converter, and provides fast and accurate operation of recirculation valves. Result: positive protection for expensive, hard-to-replace pumps. (Details on request. Ask for Item P-2.)

SIMPLIFIED AIR CONDITIONING BOOKKEEPING--WITH HAGAN RING BALANCE METERS

Comfort cooling for a complex of office buildings and shops takes big equipment. At one such location, where Hagan Ring Balance-PowrLog meters keep tab on the system, capacity is rated at 7500 tons. In this installation, chilled water flow, outgoing and returning chilled water temperature difference, and total Btu load are recorded in a single meter case. In addition, Btu load is computed and totalized on the integrator. Totalizing is in "Therms" for easy reading and bookkeeping. Since the metered totals are used in billing the amount of cooling supplied to each user, figures must be accurate. Management chose Hagan Ring Balance for this service because of its superior accuracy, reliability and the ease with which calibration can be checked. (Details on request. Ask for Item P-3.)

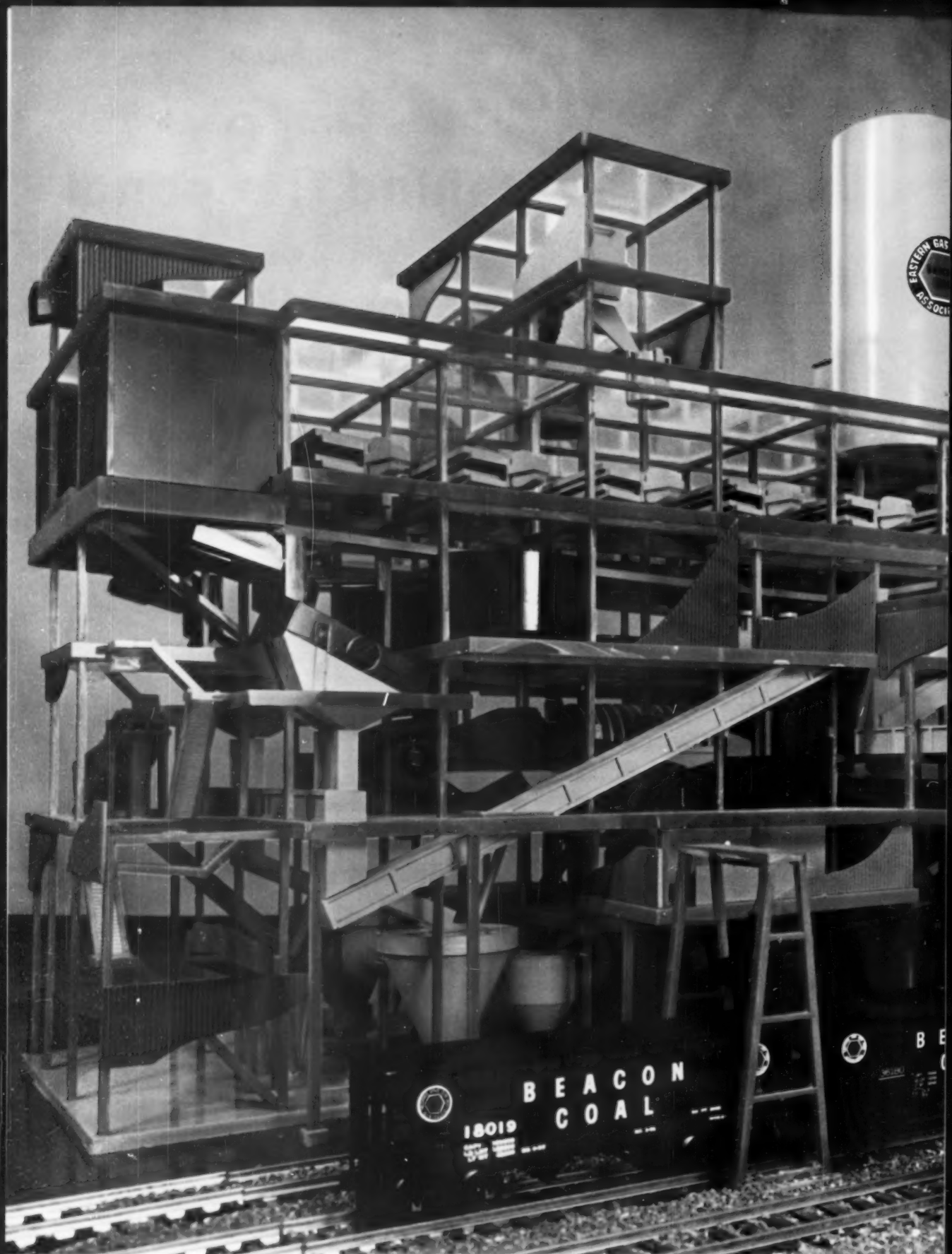
150-FOOT PHOSPHATE KILN TO HAVE HAGAN POWRMAG CONTROLS

Complete controls for a 150-foot phosphate nodulizing kiln are being provided by Hagan. The basic system will be PowrMag (magnetic amplifier) with Hagan Pneumatic Power Positioners for final control actions. Included in the system are control of: kiln hood pressure, cooler grate speed, fuel/air ratio and combustion air temperature, cooler temperature and kiln temperature. In all, there are more than twenty sub-systems, including pH control of the clarifier, oxygen content of combustion gases, kiln speed and material feed rate. All of these systems are tied together so that optimum production may be expected from the kiln. Hagan PowrMag controls were chosen because they offer accurate, trouble-free operation and minimum maintenance. (Details on request. Ask for Item P-4.)

HAGAN CHEMICALS & CONTROLS, INC., Hagan Center, Room 715, Pittsburgh 30, Pa.

HAGAN DIVISIONS: CALGON CO. — HALL LABORATORIES — BRUNER CORP.

For more data circle 521 on Post Card



This cutaway scale model shows the tipple construction of our new cleaning plant operation. It is now under construction at our Federal No. 1 mine at Grant Town, West Virginia.

WE ARE BUILDING A NEW CLEANING PLANT

. . . better, cleaner coal will come from this Eastern Gas and Fuel 12,500 tons-per-day new facility

With the completion of the new processing plant at Federal No. 1 mine, we will have the most modern facilities in the Fairmont, West Virginia, coal field. Designed to handle 825 tons-per-hour of raw coal, the new cleaning plant will produce 12,500 tons-per-day of completely cleaned, dried coal in a wide range of sizes.

The plant will be equipped with the most modern machinery for cleaning and sizing the coal. Deister tables, froth cell units and heavy media separation will be used to purify the coal, and several types of dryers and dewatering equipment provide a low moisture content finished product.

Most of the processes within the plant are automatic, including sampling of each size of coal, which provides excellent quality control.

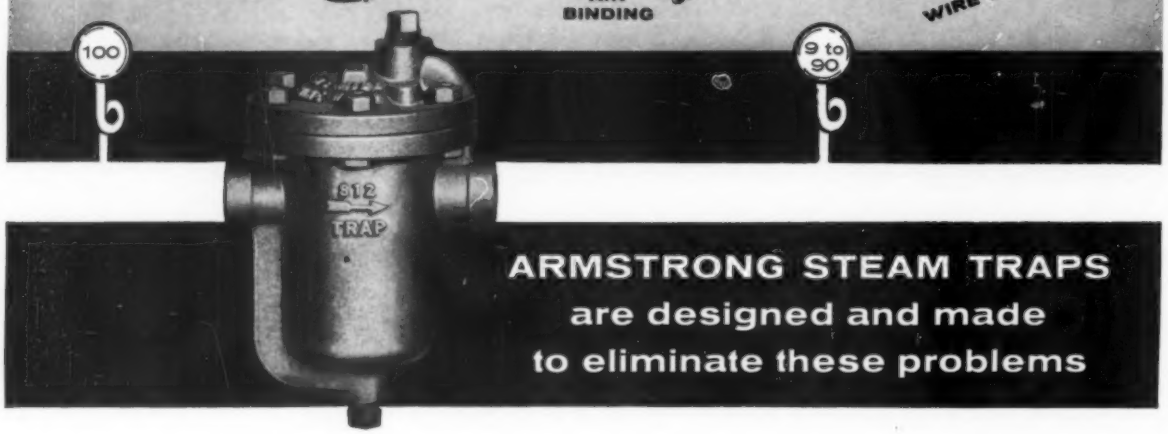
This addition to our facilities reaffirms our faith in the future of coal and our determination to continually improve our product. It underscores, too, a recognition of customer's needs and the ever expanding demand for quality coal. The new plant is now under construction, and is expected to be in full operation in early 1962.

Any Eastern representative will be glad to explain in detail how this new plant can be of service to you. Offices located in Pittsburgh, Boston, Cleveland, Detroit, New York, Norfolk, Philadelphia and Syracuse.

EASTERN GAS AND FUEL ASSOCIATES

EASTERN GAS AND FUEL ASSOCIATES

Have you ever been troubled by any of these steam trap problems?



ARMSTRONG STEAM TRAPS are designed and made to eliminate these problems

BACK PRESSURE . . . Armstrong Traps operate on any back pressure—or vacuum, for that matter. As long as there is a pressure differential across the trap, it will close on steam and open for condensate. Even the high back pressure caused by blow through of one or more traps in the system will not disturb Armstrong Traps. Other than a reduction in capacity, Armstrong Traps are unaffected by back pressure.

DIRT . . . Armstrong Traps are not affected by ordinary dirt. When the trap opens condensate swirls down under the edge of the bucket and up through the discharge orifice. Dirt is kept in suspension and discharged along with the condensate. For very bad dirt conditions, Armstrong offers traps with integral strainers. These cost less than a trap plus a separate strainer.

AIR BINDING . . . Armstrong Traps cannot air bind. Air in the system passes through a vent in the top of the bucket. It collects in the top of the trap and is discharged with the condensate. There is no chance for it to stop the trap. For low pressure on-and-off units where large amounts of air accumulate while the steam is off, Armstrong offers open float and thermostatic air vent traps in a complete range of sizes.

WIRE DRAWING . . . Armstrong Traps are designed and made to resist wire drawing. The valve and seat are tough stainless steel. The valve opens and closes tightly with a fast action and is always water sealed. There is virtually no chance for grit or sediment to lodge in the valve, virtually no chance to create conditions that lead to wire drawing.

There's no need to accept any of these problems as "inevitable." Your local Armstrong Representative can show you how to end them all. Call him today or write direct.

860 Series for low pressure heating service.

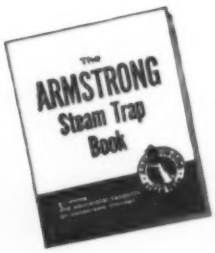
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.



The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

8109 Maple Street Three Rivers, Michigan

"See Our Catalog in Sweet's Plant Engineering File"

For more data circle 523 on Post Card

NEW *Nalprep**: KEY TO EFFECTIVE PRETREATMENT OF COOLING WATER SYSTEMS

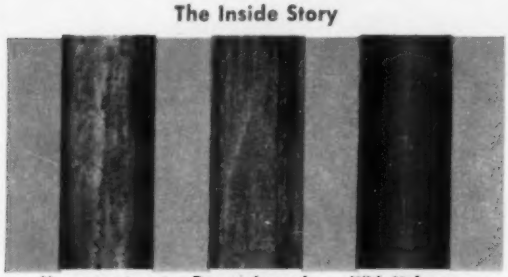
Triple-Action Treatment for Complete Preparation At Critical Points in Cooling System Life

Your experience can tell you at once that a newly-fabricated cooling system is never completely clean and free of oils, dirt, corrosion, and other contaminants . . . And that specifications calling for equipment "free of corrosion or corrosion products and thoroughly cleaned" are closer to wishful thinking than practical engineering. You know that a clean, fully-protected system will have fewer maintenance problems under the typically fluctuating conditions in a new system . . . but also that cleaning after the equipment has been in service destroys the protective film and exposes metal surfaces to rapid corrosion.

Now, with *Nalprep—and only with Nalprep*—cooling systems can be continuously, effectively, and economically protected from corrosion from the very start.

Nalprep performs three vital jobs at two critical times in the life of a cooling system. The times are: when the system is new; and immediately after cleaning. The jobs are: (1) removing organic and inorganic materials and deposits from metal surfaces, (2) preventing the clean, activated metal from reacting with anything but filming inhibitor, and (3) *at the same time* providing the initial protective film of corrosion inhibitor over the entire metal surface.

The Inside Story



No pretreatment | Degreasing only | With *Nalprep* treatment

Three identical mild steel exchanger tubes shown above received the same filming corrosion inhibitor dosages for one week. Tube at left shows rapid corrosion development when no pretreatment was given. Center tube was degreased only; shows beginnings of pitting and tuberculation. Tube at right received *Nalprep* treatment. Protective film is complete; corrosion non-existent.

Time lapses, varying from a few hours to days or even weeks, usually occur between the basic steps of construction, cleaning, testing and starting up cooling systems. These intervals expose metal surfaces to corrosion, so that when initial high-level filming inhibitor treatment is used at startup, without pretreatment, there are already corrosion sites in the system: areas which will not permit film formation to occur, regardless of the effectiveness or concentration of the inhibitor. This is why many properly-treated systems show disappointing, damaging corrosion-in-progress early in life.

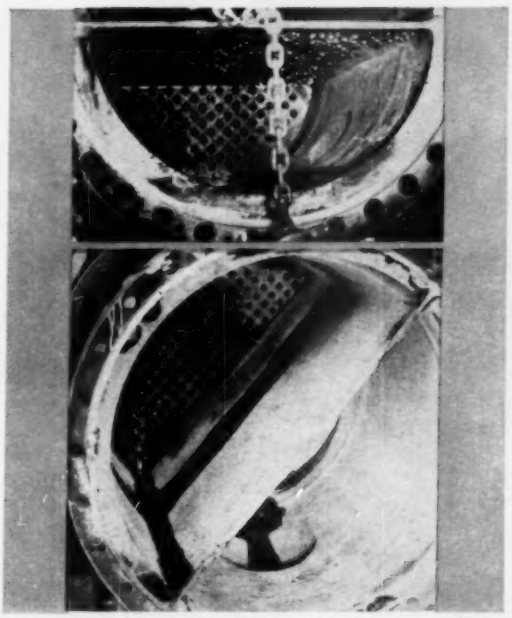
How *Nalprep* Works

Nalprep was developed to clean metal thoroughly, then protect it with corrosion inhibitor before it can react with anything else to begin forming corrosion sites. After initial *Nalprep* filming, and subsequent adequate maintenance dosages of inhibitor, corrosion need never be a problem again.

Fed to a new system in water—which ideally can be the water used for hydrotesting—*Nalprep* does a quick, complete job of cleaning and putting the initial film on all metal surfaces. Or *Nalprep* may be used to treat individual parts of a system, or to protect new equipment being added to an old system. After acid cleaning or mechanical cleaning, *Nalprep* can also be used for fast re-establishment of a tightly-adherent protective film.

It should be emphasized that high-level treatment alone is not a satisfactory substitute for *Nalprep* pretreatment.

Nalprep on the Job



Two new heat exchangers in the same cooling system are shown here after hydrotesting. New exchanger at top was not pretreated. Corrosion gained considerable headway during hydrotesting, as evidenced by the severe tuberculation visible on the baffle plate. Exchanger at bottom received *Nalprep* pretreatment. Note completely filmed baffle, tubes and sheet; absence of any corrosion residue.

Nalprep effectiveness, as illustrated above, leaves no doubt about the basic economy of including the *Nalprep* step in both new and cleaned cooling systems. Pretreatment, while adding little to overall time and cost, adds a great deal to subsequent savings in corrosion prevention, downtime and maintenance charges. Ask your Nalco Representative for details on *Nalprep*.

Nalco Technical Data Kit C4 tells the story of *Nalprep* development and results. Your copy free on request to Nalco.

**NALPREP is a Nalco Chemical Company trademark.*

NALCO CHEMICAL COMPANY

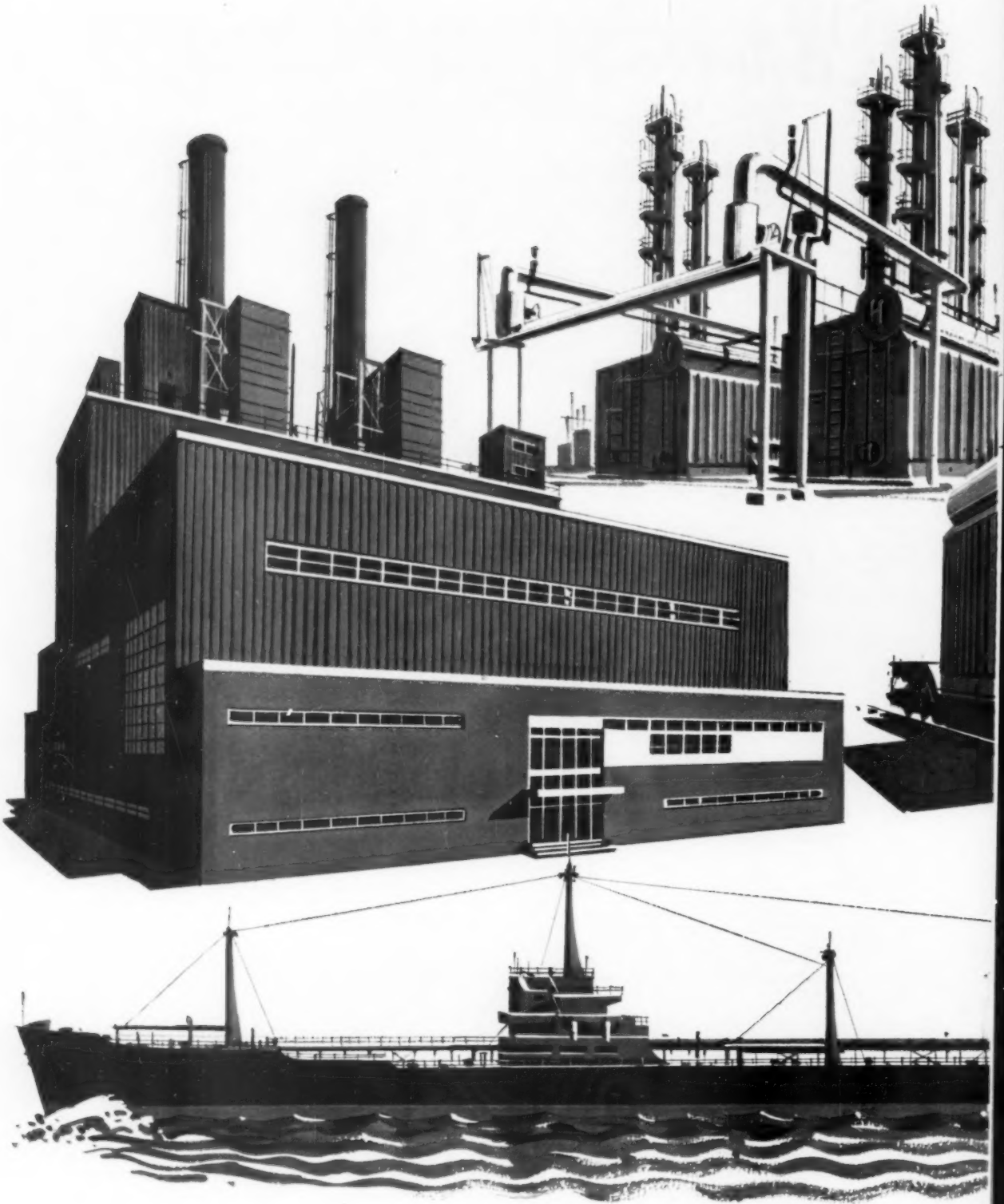
6224 West 66th Place • Chicago 38, Illinois

Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada: Alchem Limited, Burlington, Ontario

Nalco® . . . Serving Industry through Practical Applied Science

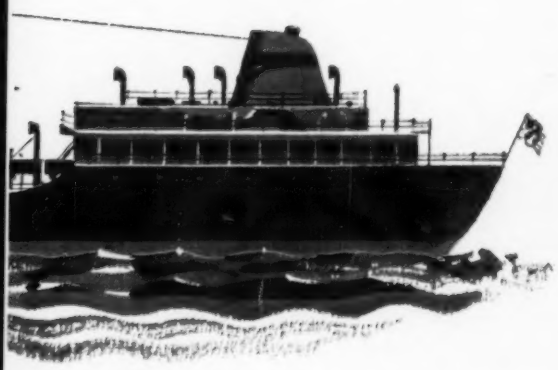
Nalco CHEMICALS
Nalco SERVICES

For more data circle 524 on Post Card



POWER PLANT PRODUCTS HEAT ENGINEERED BY FOSTER WHEELER:

Central Station and Industrial Steam Generators • Steam Condensers and Pumps • Cooling Towers
Pulverized Fuel Systems • Feedwater Heaters • Packaged Steam Generators • Nuclear Components



A broader power base to serve you

Through contributions in every field where steam power is used, Foster Wheeler has accumulated knowledge and experience that are yours today in all Foster Wheeler equipment and services.

FW-built steam generating units are identified with the central stations of leading U.S. utilities. Foster Wheeler has designed, engineered and built more nuclear steam generators and pressurizers than any other manufacturer in the world. And FW is the leading U.S. supplier of marine steam generating equipment.

In factories, oil refineries, chemical plants and every other type of installation requiring useful heat, Foster Wheeler is in the top rank of companies supplying heat transfer and steam power equipment.

When such equipment becomes your need, assure yourself of the benefit of FW's broader experience with the *full range* of steam producing components.

FW engineers, fabricates and erects them all: utility and industrial steam generators, feedwater heaters, steam condensers, evaporators, pulverizers, cooling towers, specialized pressure vessels and industrial processing plants. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.

FOSTER FW WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

For more data circle 525 on Post Card

Power Engineering

ATOMICS

308 EAST JAMES STREET
BARRINGTON, ILLINOIS

A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

March 1961

The SL-1 Accident. The unfortunate accident at the SL-1 reactor facility on January 3 once again directs attention to the terrific concentration of energy in the core of a nuclear reactor. This was a very small reactor, but it evidently suffered a nuclear excursion of great magnitude, resulting in the death of three reactor operators. At the time this is being written (the middle of January) no details of the physical damage to the plant have been released, but it is obvious that despite every safeguard that had been provided something occurred to cause a sudden nuclear reaction. At the time of the accident, however, the reactor was shut down.

Originally, the SL-1 facility was known as the Argonne Low Power Reactor (ALPR), but in 1959 its designation was changed to conform to the new AEC reactor classification system. The S stands for stationary, the L for low power, and the 1 indicates the development sequence, this being the first of its class.

In 1955, the Department of Defense notified the AEC of the need for an air-transportable nuclear power plant capable of supplying about 200 kw of electricity and 400 kw of space heat, the plant to be the main power source at a small, remote installation such as a DEW-Line radar station in the Arctic. In the preliminary studies leading to the design of the plant, six reactor concepts were analyzed, and as a result, for the prototype, a packaged plant with a heterogeneous boiling-water reactor submitted by Argonne National Laboratory was selected for development by the Army Reactors Branch of the Division of Reactor Development of the AEC. This plant was constructed at the National Reactor Testing Station in Idaho. Construction was started in the summer of 1957. Initial criticality was achieved on August 11, 1958, and on October 24, ALPR was operated for the first time, with 300 kw produced in the generator and a heat load of 400 kw.

Safety, Main Consideration in SL-1 Design. Ironically, the primary consideration leading to the selection of the design of this plant was the inherent safety of the boiling-water reactor. If reactivity is increased in a boiling-water reactor by withdrawing a control rod, the rate of heat generation increases until reactivity subtracted by steam bubbles exactly compensates for the reactivity added by the withdrawal of the control rod. The negative reactivity effect of steam bubbles occurs because the nuclear chain reaction depends on the presence of water moderator in the core. As the water boils, steam bubbles (voids) force moderating water out from between the fuel elements, and the voids provide an easier neutron leak path. Thus, more neutrons escape, leaving fewer available to promote the chain reaction. This action is called negative reactivity, and it is this effect that makes control of a boiling-water reactor easier.

The inherent safety feature of the boiling-water reactor was first demonstrated in the course of the BORAX experiments at the National Reactor Testing Station. In the BORAX experiments large amounts of reactivity were suddenly added to an open vessel boiling-water reactor. The resulting sudden formation of steam ejected great quantities of water from the core in a few thousandths of a second, thus causing automatic shutdown.

The Accident. The first indication of trouble at SL-1 on January 3 occurred at

9:01 p.m., when the automatic alarm sounded at the AEC Fire Stations and Security Headquarters. The alarm was immediately broadcast over all NRTS radio networks. At the same time, the personnel radiation monitor at the Gas-Cooled Reactor Experiment gate house, about one mile distant, alarmed and remained erratic for several minutes.

Upon receipt of the alarm, the Central Facilities AEC Fire Department and AEC Security Forces responded. The fire engines and security forces arrived at the SL-1 site, about 8 miles from the central facilities area, at approximately 9:10 p.m. Security patrolmen opened the gates in the site area fence and later the south door of the SL-1 administration building. Firemen equipped with Scott Air-Paks and radiation survey meters went through the adminstration and the support facilities in search of the operators and evidence of fire.

The initial penetration went as far as the entrance to the reactor building. There, however, the unusually high radiation levels caused the search party to withdraw pending health physics guidance. No fire or smoke nor any personnel were seen in the administration building.

At 9:17 p.m., the Phillips (Phillips Petroleum Co is operating contractor for some NRTS facilities) health physicist arrived and, together with a fireman, wearing Scott masks, made another trip through the support facilities as far as the foot of the stairs to the operating floor of the reactor building. There they encountered a radiation level of 25 roentgens per hour, the limit of the survey meter they were using. They retreated and again searched the administration and support facilities building, looking for the three men believed to be on duty. They saw no one, nor any smoke or fire.

At 9:35 p.m., two more Phillips health physicists arrived, already in protective clothing. One of them, with two firemen and with a 500 r/hr range survey meter, went up the stairs of the reactor building until a 200 r/hr radiation field was encountered. This group withdrew from the building to plan a course of action based on the radiation levels noted. With AEC approval, the other Phillips health physicist and an AEC fireman went to the top of the stairs and took a brief look at the reactor floor. Observed radiation levels of 500 r/hr forced their quick withdrawal. They saw some evidence of damage but no bodies.

Key Personnel Arrive. By 9:36 p.m. key personnel of the AEC-Idaho Operations Office (IDO), Combustion Engineering Inc (operating contractor for SL-1), and Phillips Petroleum Co had been notified. Following notification, many who played key roles in the rescue efforts had to travel from Idaho Falls 41 miles to the SL-1 site. At 10:25 p.m. IDO designation of a Class I disaster was broadcast over the NRTS radio network.

When four Combustion Engineering personnel, including the SL-1 plant health physicist, arrived, they decided to enter the 500 r/hr field. At 10:35 p.m., these men, wearing Scott Air-Paks and carrying two 500 roentgen scale meters, entered the reactor operating floor for less than two minutes. They saw two men; one moving. They withdrew and returned with two more Combustion Engineering men and an AEC health physicist.

One Still Alive. Two of the group picked up the man who was alive and put him on a stretcher at the head of the stairs. The other three of the group observed that the second man was apparently dead. The group got the stretcher down the stairs and out of the building within three minutes of entry, and put the stretcher in a panel truck. The panel truck met the ambulance on Highway 20, where the AEC doctor examined the victim and pronounced him dead at 11:14 p.m. The ambulance returned to the SL-1 site pending a decision on the temporary disposition of the body.

At about 10:48 p.m., another group, made up of two military and two Phillips personnel, went on the reactor floor to locate the third man. They located him and determined that he was dead and did not attempt to remove him.

The recovery group went to the Gas-Cooled Reactor Experiment (GCRE) for preliminary decontamination. Gamma exposure of the five-man group ranged from 23 to 27 roentgens. Having concluded that the remaining two operators were dead, the

AEC-IDO health physicist suspended rescue efforts and ordered all personnel back to the roadblock established on Fillmore Blvd at Highway 20.

Decontamination of Body. After the ambulance had been returned to SL-1 to await a decision on disposition of the body, personnel involved in the transfer of the body from the panel truck to the ambulance went to the Central Facilities dispensary for decontamination. Between midnight and 3:00 a.m. on January 4, approximately 30 people were admitted to the dispensary for secondary decontamination. Preliminary badge readings and urine sample analyses for these 30 people were received around 3:30 a.m., and indicated that all personnel could be released.

At approximately 6:00 a.m., January 4, a team of five men removed the body from the ambulance located in the SL-1 area. The body was disrobed in order to remove as much contamination as possible at the site. It was then replaced in the ambulance, covered with lead aprons for shielding purposes, and transported to the Chemical Processing Plant where surface decontamination was attempted. Individuals involved in the disrobing and transfer process received a maximum exposure of 770 millirems gamma. Prior to decontamination the reading from the first body was approximately 400 r/hr at the head region, approximately 100 r/hr at the feet, and from 200 to 300 r/hr over the remainder of the body. First efforts to decontaminate the body resulted in no significant decrease in the readings.

Second Body Recovered. Between 7:00 a.m. and 11:00 p.m. on January 4, several entries into the reactor buildings were made, and the second body recovered. Preparations for the recovery of the second body began at 4:00 p.m. This body was located in an area where radiation levels were estimated to be approximately 750 r/hr.

A recovery team consisting of six military personnel and two AEC health physicists were extensively briefed and rehearsed in the procedure to be followed. Attired in protective clothing, they reached the entrance of the SL-1 compound about 7:30 p.m. Of this group, two military men and two health physicists entered the support facilities building and placed a blanket on the floor of the control room. Because of the high radiation levels to be encountered, the maximum permissible working time on the reactor operating floor was limited to one minute. One health physicist was assigned to hold a stop watch and time the actual entrance, signaling the two-man recovery team when their time was up. The other health physicist remained in the support facilities building to check the body for radiation after its removal from the reactor building.

Having been briefed as to the location of the body, the two-man team entered the reactor operating floor. One man picked up the victim's legs while the other grasped the body around the shoulders, and they moved rapidly out of the high radiation area, down the stairway and into the control room. There they placed the body on the blanket. Next, the second two-man team went to the control room and picked up the body by the four corners of the blanket and carried it out of the SL-1 compound. The work clothing was removed from the body, which was then placed in an ambulance and transported to the Chemical Processing Plant. In the meantime, the third two-man team proceeded onto the operating floor in an effort to gain more information about the remaining body and the condition of the reactor.

The short periods of time that these recovery teams were in the high radiation areas on the reactor floor resulted in gamma exposures of from 1 rem (roentgen equivalent man) to about 13 rems.

On Thursday evening, January 5, an official photographer entered the radioactive reactor compartment to photograph the scene of the explosion. Radiation fields greater than 500 r/hr were reported by the accompanying health physicists. The photographer, wearing protective clothing and breathing apparatus, was allowed 30 seconds to complete his assignment. By entering the compartment only long enough to trigger his camera and withdrawing to a less radioactive area to change film and make adjustments, the photographer was able to obtain the interior photographs needed.

The Third Body. The third body had been observed to be lodged in the ceiling above the reactor. Because of the high radiation fields (above 500 r/hr), personnel

could not climb onto a beam to free the body which itself was highly contaminated with radioactive material. The plan for removal of this third body was to position a large net under it and attempt to lower the body onto the net. The net itself was fastened to the end of a crane boom. The large doors on the reactor building were opened to permit the crane to position the net just below the body. A closed-circuit TV camera had been placed in position to help position the net.

When the net was in position, teams of two men each were to move quickly and try to lower the body onto the net. Each team had less than two minutes to make the attempt at freeing the body. Altogether, five two-man teams were used to free the body and lower it into the net. The third body was removed from the building at 2:37 a.m. on January 9, six days after the accident. The estimated doses received by the men involved in freeing the body ranged from 2.5 to 7.5 rem.

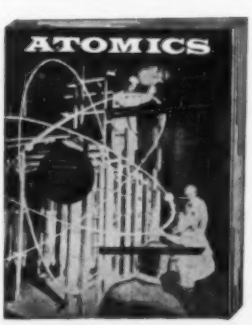
Further Investigation. Details of the physical damage to SL-1 have not been released, but even if it proves to be less than expected, it would be unwise to mitigate the seriousness of this accident. First, it is a blot on the AEC's splendid safety record -- a record in which everyone involved can take justifiable pride. Second, until the true cause of the accident is found, it casts a shadow upon our confidence in the inherent safety characteristics of the boiling-water reactor. SL-1, it must be remembered, was a very small reactor; its design thermal output was only 3000 kw. This compares with a reactor thermal output for Dresden Station of 626,000 kw, and one cannot help wondering what might result if similar accidental conditions prevailed in a reactor of Dresden's capability.

There is little doubt that every effort will be made to determine the true cause of the accident. On January 10, AEC's General Manager, A. R. Luedecke, announced the appointment of an Ad Hoc Advisory Committee on the future use or disposition of SL-1. Another board has been set up to inquire into the cause of the accident.

Accident's Bearing on Exclusion Area. The accident has a definite bearing on electric utility companies' desire to locate nuclear power stations close to the load centers; that is, close to densely populated areas. Thus far, the AEC has not approved such plant siting. Municipal governments also have opposed the location of nuclear stations close to their cities. This accident, therefore, strengthens the arguments for siting nuclear power stations away from populated areas.

The Victims. As they searched for explanations early in January, AEC agents were confronted by another sorrowful problem of the atomic age: What to do with the bodies of Seabee Electrician Richard Legg, 26, Army Specialist John Byrnes III, 22, and Army Specialist Richard McKinley, 27? Since they will long be radioactive, they would have to be buried in lead coffins in some secluded area or consigned to the sea. Ours is a complex age, indeed.

Andrew W. Kramer



Reprint Notice. Reprints of the ATOMICS section from POWER ENGINEERING for the six months from July to December 1960 are now ready, and are available at $1.00 per copy. If you want one of these reprints, please fill in the following form and send it to

Editor, ATOMICS, % POWER ENGINEERING
308 East James Street, Barrington, Ill.

Enclosed is my $1. Please send me the reprint as soon as it is ready.

Signed.....

Address.....

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

The whole works—steam trap, strainer and blow-down valve—fit in the palm of your hand

ENTHUSIASTIC APPROVAL!

INDUSTRY WELCOMES NEW SERIES 130 IMPULSE STEAM TRAP WITH OPEN ARMS

"Radically new and different—send 50."
TEXAS INDUSTRIAL

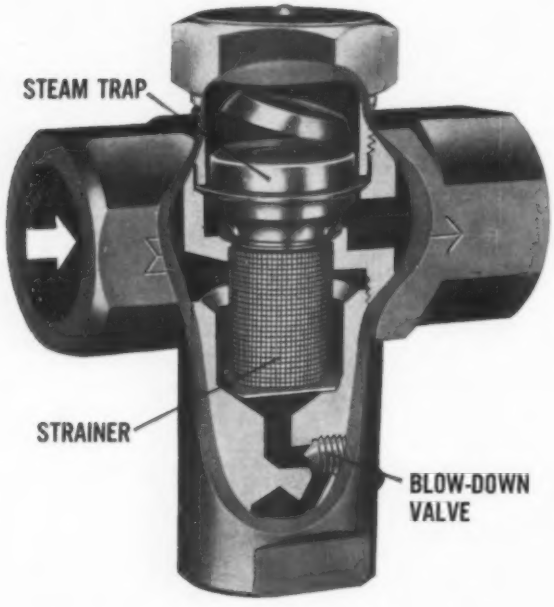
"We want 100 immediately. They meet our confined space needs perfectly."
WISCONSIN PACKER

"Ordering 60 as first part of new standardization program."
LOUISIANA REFINERY

"We'll start with 24—more later."
OHIO PETRO-CHEMICAL

So it goes—industry's welcome to the new Yarway Series 130 combination steam trap has been a warm one. Already manufacturing quotas have been doubled to meet the demand. Yarway distributors everywhere are busy answering their customers' requests for demonstrations.

What will the new Series 130 do for you? Consider these advantages:



COMPACT COMBINATION SAVES SPACE, MONEY, MAINTENANCE ON LIGHT LOAD APPLICATIONS

Steam trap, strainer, blow-down valve combination simplifies trapping hook-ups—saves up to 30% in time and materials over ordinary hook-ups.

NO OTHER STEAM TRAP COMBINES SUCH COST-SAVING, WORK-SAVING FEATURES

All stainless steel construction, woven stainless steel strainer screen, replaceable trap valve-seat assembly, Allen wrench-operated blow-down valve—make maintenance easy.

Small size, light weight, good for all pressures 8 to 600 psi—make installations simpler.

Try this trap on your steam main drips, steam tracer lines, meter boxes or any other of thousands of light condensate load applications. Call your nearby Yarway distributor today—or write us for more details.

For more data circle 526 on Post Card

PUMPED-STORAGE HYDROS ADD PEAKING POWER AND STEAM CAPACITY FACTOR

FARGO ENGINEERING'S PRESIDENT, H. S. HUNT JR., EXPLAINS

BASIC TYPES OF PUMPED STORAGE—AND DISCUSSES ECONOMICS INVOLVED

IN RECENT YEARS, many utility companies have been giving intense study to their peak-load problems. Among the various schemes available for "peak-shaving," the pumped-storage hydro plant offers one of the best possibilities.

The pumped-storage principle is not new in the electric generation industry as a method of furnishing peaking capacity (while at the same time increasing night loads). However, only recently has it gained acceptance as a major consideration in the future generating plans of electric power companies in this country. It is an economical, technically-feasible, and practical method of meeting system peak loads, while at the same time improving the thermal plant capacity-factor during off-peak hours.

Briefly stated, the principle relating to the operation of the pumped-storage hydroelectric plant consists of pumping water from a low-level source to a high-level storage reservoir by using low-cost, off-peak energy, and then releasing the stored water through hydraulic turbines during periods of peak loads.

Generally speaking, there are three types of pumped storage projects as follows: Pure pumped storage, pumped storage with diversion, and combined and conventional hydro. In this scheme, the upper storage reservoir would have no inflow of water other than that which was pumped from the low-level source. The *pumping-head* of such a plant would be approximately the same as the generating-head, with any variation resulting from change in water-levels of the reservoirs, due to the pumping (and generating) operation — and friction losses in the pipeline.

Pure Pumped Storage with Diversion: This type of plant would require unusually favorable topography whereby water (pumped from a low-level source) could be stored at a higher elevation, then transported by tunnel (or canal) to a point where it could be released through hydraulic turbines under a greater head than the pumping-head. The same amount of water would pass through the turbines as through the pumps, with the exception of any losses which might occur, such as evaporation.

Combined Pumped Storage and Conventional Hydroelectric Plant: There could be many schemes under this heading, but in all cases the over-all project would have the added benefit of energy developed from the natural inflow of water to the upper reservoirs. In a plant of this type it would be expected that more water would pass through the turbines than through the pumps.

The pumped-storage principle has been applied in Europe, for many years, with great success. Many such plants have been operated for a great number of years in Germany, Switzerland, and Austria. And, more recently constructed pumped-storage projects have operated in Italy and England as well. Although the first pumped-storage plant was built in Europe before the year 1900, the first notable plant to be built in the United States was the Rocky River Plant in Connecticut, which was constructed in 1928.

Typical pumped-storage plant is the gigantic project under construction at Niagara Falls

Many years passed before other pumped-storage plants were built in this country, and it was not until 1950 that the Buchanan plant was built in Texas. Subsequently, other plants have been built at TVA's Hiwassee Plant, and as a part of the Colorado–Big Thompson water diversion project. Others are presently under construction or in the design stage, with plans for early construction.

Most notable of these proposed plants are the Tuscarora Plant (Niagara Power Project), the Union Electric Company's Taum Sauk Project in Missouri, and the Appalachian Power Co's Smith Mountain project in Virginia. The Sir Adam Beck pumped-storage plant (on the Canadian side of Niagara Falls) has been in operation for some time.

In the past, a significant deterrent to the application of

the pumped-storage principle, in this country, has been the progressive increases in efficiency in the field of thermal generation. This alone has made the search for other types of peaking generation quite unnecessary until recently. Today many utilities are investigating the possibilities which pumped storage may offer for them in their system areas.

Some, who investigated such possibilities many years ago, are reviewing these past studies in the light of new concepts and developments in the field of pumped storage. The results of many of these investigations have prompted more detailed studies of prospect today.

No two studies are similar since no two systems would be expected to be alike, nor would the topographical features of their areas be alike. In some areas there would be an abundance of prospective sites, while in many areas there would be only a few sites which would prove to be feasible. Also there would be some areas where no pumped-storage sites would exist.

In carrying out the study, it must be determined whether the plant is to operate on the basis of nightly, daily, weekly, or seasonal storage; and the efficiency of any scheme so selected must be related to the economy of the project. In one instance, a pure pumped-storage plant might prove to be the best installation for the system, while in other cases a combined pumped-storage and hydroelectric plant (or a pumped diversion project) might present the best solution. The possibilities of making additions to the capacity of an existing conventional hydroelectric power plant should not be overlooked when making pumped-storage studies.

It is quite possible that many feasible sites are now being overlooked in the belief that sufficient head is not to be found in a certain area. Generally, and from an economical standpoint, the minimum head for a *pure pumped-storage project* would be in the neighborhood of 250 feet. Also, the minimum head for a *combined pumped-storage plant* (with a conventional hydroelectric project) could be considerably less than 100 feet, depending on related circumstances.

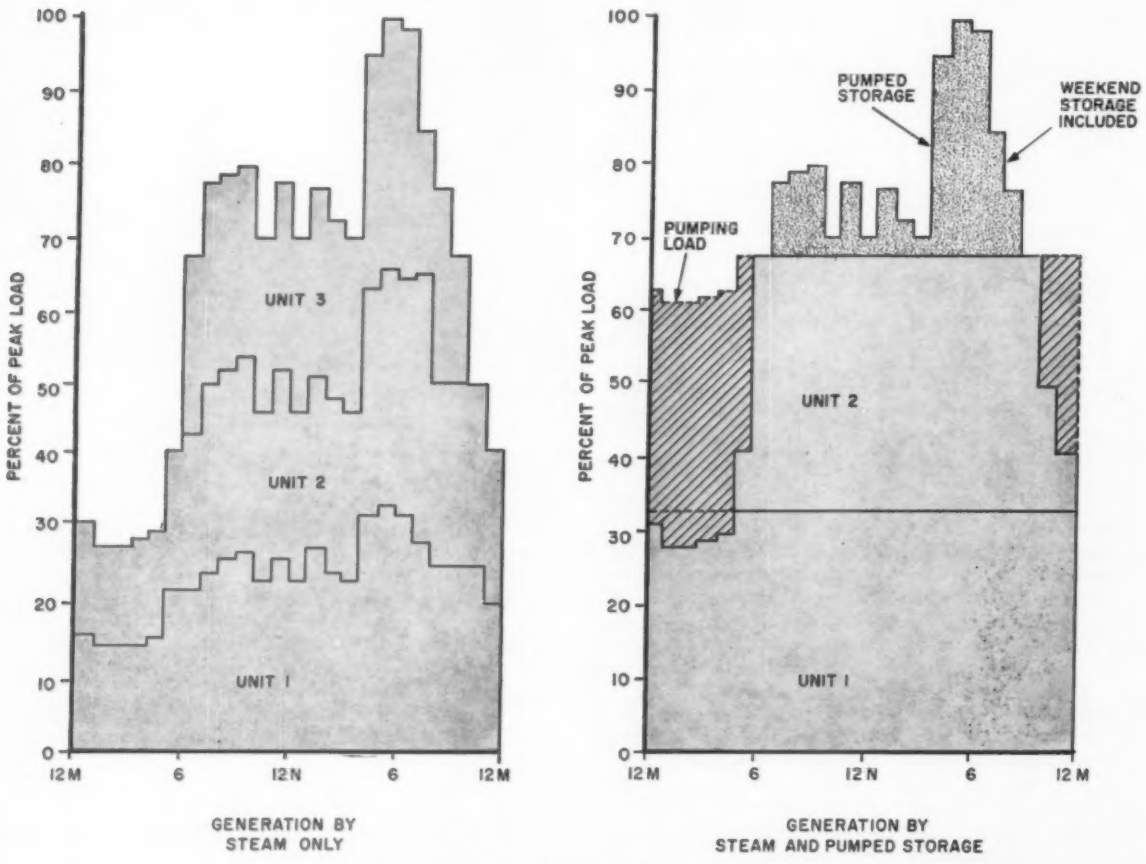
Pumped-Storage Project Economics

Cost of a pumped-storage project would normally be expected to increase as the head decreased. This cost will also be affected by plant size. However, there are instances where a high-head plant may cost as much per kw as a plant with a 300-foot head if the reservoir costs of the high-head plant exceed the reservoir costs of the low-head plant by a considerable margin.

Construction costs for pumped-storage plants can be as low as $100 per kw, provided all factors were favorable. In any case, the cost of such a project (for many systems) would be competitive with the cost for alternative steam.

Over-all efficiency of the pumped-storage plant is of great importance to the economy of the plant. A true economic evaluation of a project can be made only by considering the effect of the project on the operation of the entire system. For instance, it is obvious that it would require more power to pump a certain volume of water to a high level than could be obtained from the same water falling through the same distance.

A pumped-storage plant requires approximately 3 kwh of energy *from* the system for every 2 kwh *returned* to the system. However, it can be shown in most cases,



if economy energy is available for pumping, the addition of a pumped-storage plant to a system will be one which is economical, and will compete favorably with other types of peaking generation.

Over the years, the over-all efficiency of the pumped-storage plant has been improved considerably. In 1900 an over-all efficiency of 40 per cent was about as much as could be expected. Today, efficiencies of 65 to 70 per cent are not at all uncommon. It has recently been reported that the Reisach project in Bavaria has realized an over-all efficiency of 75 per cent.

One objection to the pumped-storage plant is that it will not furnish plant capacity on a 24-hour basis, such as a thermal plant would be capable of doing. Actually, it should not be expected to operate in such a manner. The principal function of the plant is to furnish system peaking capacity. In so doing it *increases the capacity-factor* of the system's thermal units, and the *load-factor* of the system.

Consider Capacity Requirements

Power systems must have sufficient capacity to meet the highest anticipated power demand, with additional capacity available for use in case of emergencies. When the above requirements have been met, it is apparent that all generating units cannot be operating continuously, as the difference between the peak and the valley of the load curve is often great enough to make continuous operation of all units undesirable and probably impossible. Even during times when such continuous operation might be possible, certain units would be operated at a low capacity-factor, which is costly.

In a system which is predominantly thermal capacity, one or more of the units (operated to supply part of the load during peak hours) must, in most cases, be shut down, or put on standby, at night and on week-ends *during the off-peak hours*. Such requirements result in expensive system operation.

If the pumped-storage plant were considered *alone*, as an economic entity, it would be justified only if the *power generated* on the peak loads could be sold for an amount sufficiently greater than the cost of the power *required for pumping*, more than to cover the operational and investment costs of the plant. However, there are several benefits to be derived from the installation of a pumped-storage plant, and in many cases it is possible to establish a monetary value for these benefits. There are also many intangible benefits for which it would be difficult to establish a dollar value, but for which it is relatively easy to recognize as a benefit to the system.

Improvement of the operation and efficiency of the *thermal or nuclear plant* is a very important aspect of the pumped-storage plant because of its ability to store the system's economy-energy for use as peaking capacity, when needed over a few hours each day. Such operation reduces the requirement of large fluctuations of thermal plant loads.

It is generally found that the incremental energy costs of a system are very low when increasing generation from a low-load-factor to a high-load-factor. In some cases, it has been shown that an incremental savings of as much as 0.15 mills per kwh would exist, even after allowing for the loss of efficiency in the pumping and generating cycle, and with no credit taken for the elimination of the higher costs which would most likely be experienced in the incremental maintenance costs.

It has been said that the low *installed* cost of some types of peaking generation have appeared to be very attractive until studies are made relative to the cost of *operating* them. Once installed, these peaking plants are forced to operate at the same heat-rates throughout the life of the equipment, regardless of increases in efficiency which may be realized in the progressive development of equipment in the years ahead.

In considering the operational cost of a pumped-storage plant, it would be expected that the plant would depend on the most efficient thermal units for pumping-energy. It can therefore be seen that as new, more efficient thermal (or nuclear) units are added to the system, their benefits will extend to the peak generation of the system through the pumped-storage plant. (The incremental cost of energy, produced by the pumped-storage plant, is a direct function of the cost of off-peak economy energy which is used for pumping.)

Thus, as a hypothetical illustration, if at some future date the incremental cost of energy, produced by a highly efficient thermal (or nuclear) unit, were as low as 1 mill per kwh, and surplus energy from the unit were available for pumping, the resultant incremental peaking cost of the pumped-storage plant would be 1.4 mills per kwh. This is based on an over-all pumped-storage plant efficiency of approximately 72 per cent, whereas the incremental energy cost of peaking generation from other types of peaking capacity (which were installed previously) would not be able to take advantage of such an increase in efficiency.

In many systems the installation of a pumped-storage plant would postpone the need for a new thermal unit for several years, at which time a much larger unit than previously planned could be installed, with the assurance it would be fully loaded.

In any growing system, management is faced with the prospect of installing thermal units of a much larger capacity than that of existing units in order to eliminate the possibility of fostering a system which is made up of many small units. The larger units are usually more attractive than the smaller units, from the standpoint of system operation and economics, provided the new unit can be base-loaded.

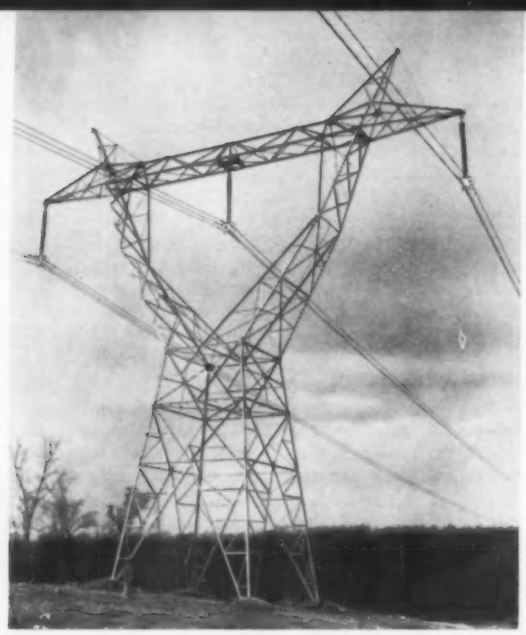
If the new unit cannot be base-loaded, it becomes apparent that capacity is being paid for which cannot be used advantageously for some time. In some cases, such an uneconomical operation as part-loading could be tolerated in the anticipation that the load would grow to fit the equipment. However, in such an instance no provision is made for the condition which would exist if the load *did not* grow as fast as anticipated.

Some Other Benefits to Consider

(1) Flexibility of system operation and maximum reliability of units; (2) permits interchange of excess economy power; (3) effectively supplies short-duration additional peak power without the expense of maintaining spinning reserve; (4) provides hydroelectric power for emergency service, with great speed — the power being available almost immediately; (5) small operating staff (if plant is not automatic), and fewer personnel required if plant is made automatic; and (6) provides generation of reactive power when motored.

There is little doubt that peak loads of generating systems will grow sharper as the system load grows. The problem of peaking capacity cannot be overstated. The worst thing that can be done is to accept only an expensive method of meeting these peaks. Accordingly, a bold and fresh approach is required, strengthened by a willingness to investigate a fundamental principle such as pumped storage, as a means of meeting system peak loads. Also, as a means of loading thermal units during off-peak periods, thereby making full use of incremental economy energy.

Pumped-storage projects are playing a very important part in the operation of many power systems today, and their use can be expected to increase steadily both abroad and in this country. THE END



ANOTHER EHV TEST LINE GOES INTO OPERATION

TVA'S K.E. HAPGOOD DESCRIBES 460–500-KV EXPERIMENTAL LINE SECTION

TVA IS BUILDING seven miles of 460–500-kv transmission line to gain design and construction experience, and to appraise the value of extra-high-voltage transmission for the TVA system. The EHV line section is part of a 52-mile, 161-kv line being built to connect TVA's 1,275,000-kw Johnsonville Steam Plant to its system at Lawrenceburg, in middle Tennessee. The line was put into operation at 161 kv in early February.

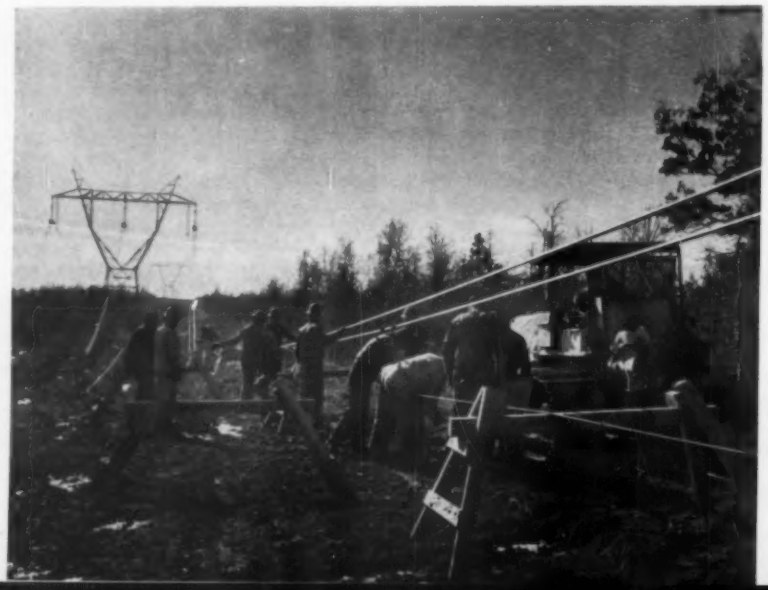
This 460–500-kv line section traverses terrain varying in elevation from 820 to 1020 feet above sea level, in an area having an isokeraunic level near 60. The shortest span is 815 feet, and the longest is 2216 feet. A total of 34 single-circuit, 460–500-kv steel structures are used; and 30 tangent and 4 small-angle (4°) structures.

Conductor configuration is flat, with a minimum of 37 feet (between phases) in the spans, and 42 feet at the structures. The two overhead ground wires (of 7/16 in. high-strength steel) are spaced 64.5 feet apart at the tower and are 10 ft 9 in. horizontally inside and 32 ft 11 in. above the outside phases, providing a protection angle of about 19 degrees. The mid-span clearance, ground wire-to-phase-conductors, is approximately 37 feet. The phase-conductor-to-ground clearance is a minimum of 34 feet, with a minimum of 40 feet over main highways.

The insulation consists of twenty-four 5¾ by 10 in. 25,000-lb-rating suspension units. Phase conductors consists of three 954 mcm ACSR (Rail) conductors on 18-in. centers, with the apex of the triangle at the bottom. In cases where armor rods are used, they will be fitted with corona bells.

The EHV section uses three different types of conductor hardware and corona shields; four different types of spacers are used for the three-conductor bundles. Within selected lengths of line, however, only one type of hardware, corona shields, and spacers was used. Spacers are located 240 to 315 feet apart, depending upon span length. Wood poles are used for temporary dead ends at each end of the 460–500-kv section.

Magnetic links are installed on each leg of each 460–500-kv tower, and also on each 161-kv steel tower, for about a mile beyond each end of the EHV section. These links will provide information as to the lightning performance. A more elaborate arrangement does not appear to be justified at this time. THE END



POWER FOR STRIP MINING OF COAL

D. G. JOHNSTON, PEABODY COAL CO'S VICE-PRESIDENT IN CHARGE OF STRIP OPERATIONS, DESCRIBES LYNNVILLE MINE IN INDIANA

ROUGHLY 80 PER CENT of Peabody Coal Co's production is by the strip, or open-cut, method of mining. During 1959, 24 mines of this type were operated in the states of Illinois, Indiana, Ohio, Kentucky, Missouri, and Oklahoma, producing slightly over 20,000,000 tons of coal. This does not represent the full capacity of these mines as some were acquired during 1959, and only that coal produced after acquisition is counted in this figure.

The loading and shipping of such a tonnage is a big job, but the removal of the overburden from 20,000,000 tons of coal borders on the tremendous. Peabody machines moved 206,000,000 cubic yards to accomplish this, which is about equivalent to digging a ditch 60 feet wide and 15 feet deep all the way from New York to Des Moines, Iowa. However, unfortunately, not much of the stripping was done at depths of 15 feet. As a matter of fact, a considerable amount of it was done in depths exceeding 100 feet, an accomplishment which was only dreamed of a few years ago.

Not too long ago a shovel that would spoil dirt from a cut 50 feet deep was considered quite a machine. With the gradual depletion of the more shallow reserves, equipment manufacturers have responded to the demand of the strip coal operators for bigger and better machines which would economically expose the deeper veins of coal, with the result that we are now seeing electrically-powered, mobile giants in the pits; and in the not too distant future we will be able to observe one weighing more than 6500 tons removing the overburden from the coal and propelling itself, all by means of electric power.

In 1959, Peabody used 46 machines ranging in size from a small 5-yard type to the giant 70-yard size capable of moving over 25,000,000 yards annually by itself. Three of these larger machines were at work during the year as well as two slightly smaller 60–65-yard shovels.

The 70-yard shovels, in moving mountains of earth, require large amounts of electric power. A rule-of-thumb guide to their power consumption is that it requires 0.5 kwh of energy to move a yard of dirt; so several of our shovels are in the million-kwh-per-month class. One of our largest power users has a peak demand of around 8000 kw and has a total connected load of 6550 hp ac at 6900 volts.

It is not unusual for the remainder of the mine equipment, such as preparation plants, loading shovels, drills, etc, to use as much power, or more, than the stripping shovels. So it is evident that Peabody Coal Co, besides being one of the largest suppliers of fuel for power, is also a large user of this commodity. In 1959 the strip mines alone used 180,407,967 kwh of energy at a total cost of $2,439,001.

Lynnville Mine

Perhaps the easiest way to describe a modern strip mine operation would be to take as an example one of the Peabody mines and follow its operation. For this purpose we will use the Lynnville mine, located in Warrick County, Ind., served by both the New York Central and Southern Railway Co, and also by a private railroad connecting with a river dock at Yankeetown, Ind., on the Ohio River, and with the new smelting plant of the Aluminum Company of America.

Before going into the actual operation of the mine, it must be understood that many months, and sometimes years, of preparatory work go into the making of a mine. First the coal must be located, its extent,

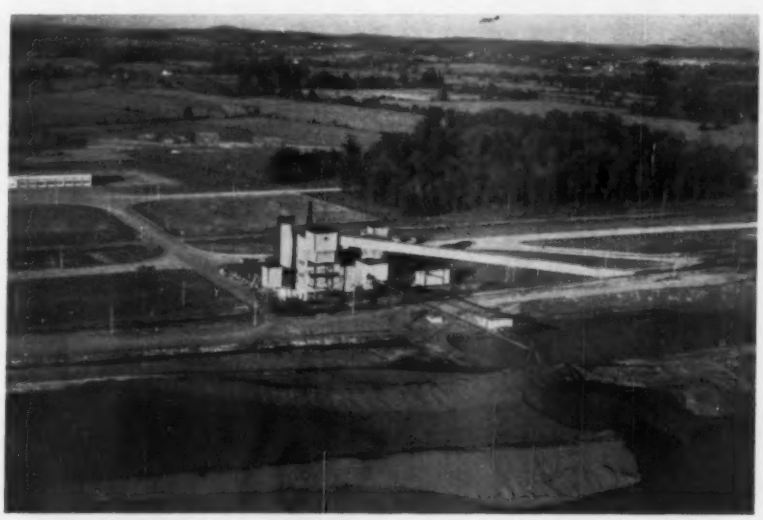


Fig. 1. Washing and preparation plant, or tipple, at Lynnville

COAL—FROM MINE TO BOILER

Second of a Series Which Began Last Month

Fig. 2. Pit at Lynnville showing uncovered coal seam, loading shovel, and vertical drill. It's Indiana No. 6 seam

Fig. 3. Marion type-5761 shovel does stripping at Lynnville, has 65-cu yd bucket. Haulage trucks hold 40 tons

thickness, depth of overburden covering it and quality determined. This is the work of a division of the Peabody engineering department. Prospect drills will work on a likely coal area until we know almost to the ton how much coal lies within the area, how many yards of dirt we shall have to move to get to the coal, the character of the overburden — that is, how much dirt, shale and rock will have to be moved — and finally the analysis of the coal.

All of these are important factors in determining whether an economical mine is possible at this particular location. Marketing possibilities are constantly being investigated, and even though a suitable mine site may be available, it will not be developed until marketing conditions are favorable. So much for the preliminary work, but with the realization that its magnitude and importance are not adequately conveyed by these few words.

The Lynnville mine operates on the Indiana No. 6 seam of coal, which is a split seam in this area, the upper portion of the seam relatively constant at a thickness of about 30 inches, the lower portion varying in thickness from about 12 inches to 8 feet in the area which has been worked. The shale parting between the upper and lower parts of the seam varies from 1½ feet to 12 feet, most of it between 4 and 12 feet, and contains enough hard, sandy material in spots to make drilling with a rotary drill necessary at times. In the particular area now being worked the overburden gets as deep as 75 feet and is mostly a medium hard shale.

Using the 5761

Stripping is done at the Lynnville mine with what is now the world's largest shovel, a Marion type-5761 with a 170-foot boom and a 65-cubic yard bucket, electrically powered. This machine will use about 1,000,000 kwh of energy per month, and has 6550 connected ac horsepower. To date its performance has been averaging over 3200 cubic yards per hour operating time, which is exceptionally good considering that this machine also strips the thin parting between the seams, a condition which makes it difficult for the shovel to fill its bucket.

Preparation of the overburden for removal by the shovel is a very important part of the operation, and can greatly affect the performance of the shovel. Large modern shovels are not so much tools for digging as they

are a means of conveying earth from one point to another; so it is important that the material conveyed be such that it is easily obtained from the bank, and important seconds are not wasted in clawing a bucketful of overburden during each cycle. This preparation is accomplished by means of explosives.

At Lynnville, 10¼-in. diameter holes are drilled horizontally into the high wall ahead of the shovel, loaded with ammonium nitrate explosives, and detonated with primacord. The spacing of the drill holes and the amount of explosives used in each hole is determined by the height and hardness of the overburden. During the past six months 1,890,369 pounds of explosives have been used here.

The 5761 will strip down to the upper bench of the coal seam, casting the overburden to the side into an old pit from which the coal has been removed. Following the shovel will come a smaller, 7-cubic yard machine loading the exposed coal into 40-ton capacity semi-trailer haulage units. Before loading, the coal has been cleaned somewhat by means of a bulldozer which pushes off the loose rock and dirt left by the stripping operation. The loading of this coal exposes the parting which covers the bottom bench of the seam. Since it is necessary to drill and shoot this parting, a rotary air drill follows this loading machine, drilling holes for the placement of explosives.

At a point previously decided upon as suitable and where the top seam of the coal has been removed, the 5761 will turn around and begin the removal of the parting from the bottom seam. This coal will then be given a preliminary cleaning by a bulldozer and then loaded out by means of another 7-yard loading shovel. Meanwhile the other loader will be loading coal in another part of the pit.

Hauling and Preparation

At Lynnville the coal is hauled from the pit to the preparation plant by means of nine semi-trailer bottom dump haulage units each of 40-ton capacity, over a privately-built and maintained haulage road.

Since the haulage roads must withstand loads of up to 150 tons at speeds as high as 45 mph, their construction must be rugged. The usual practice in building these roads is to construct a well-drained and compact earth grade. On top of this is placed from 1½ to 2 feet of shale, which is rolled and graded until smooth and well sealed to avoid moisture penetration as much as possible.

Then as a finish coat, crushed rock of about 1¼-in. size is applied preferably while traffic is using the road, to finish sealing the surface and give a skid-proof roadway.

Correction . . . Last month's article on Peabody's No. 10 mine reported annual production there as 400,000 tons. This was a slip in arithmetic. The figure should have been 4,000,000 tons, of course. No. 10 is the world's largest underground coal mine.

At the preparation plant, or tipple, the coal is cleaned, sized and loaded into railroad cars, or trucks. This is a sizable operation at Lynnville, requiring a work force of 40 men for two shifts. About 1000 tons per hour of raw coal is processed at this plant, from which about 800 tons per hour of the cleaned, finished product is obtained.

The cleaning process consists of washing in two McNally-Norton washboxes for all sizes of coal, then a secondary cleaning of the ¼-in. minus product over a battery of Deister tables. The 1-in. minus product is dried by means of Vissac driers, Bird-Humboldt centrifuges and a Dorr Flue-Solids drier. The connected load at the tipple is 3478 hp.

All these steps of conveying, sizing, washing and drying in the plant require very substantial amounts of electrical energy — 2.79 kwh per ton of coal, or about 5,500,000 kwh each year on Lynnville production of approximately 2,000,000 tons. THE END

In 1959, Peabody's strip mines used 180,407,967 kwh of energy. Here's the electrical score for Lynnville

		Capacity
TIPPLE		
Run of mine belt	440 volt	150 HP
Washed coal crusher	440 volt	150 HP
Exhaust fan drier #1	440 volt	125 HP
Exhaust fan drier #2	440 volt	125 HP
Recirculating pump #1	440 volt	100 HP
Recirculating pump #2	440 volt	100 HP
Recirculating pump #3	440 volt	100 HP
Fresh water pump #1	440 volt	125 HP
Fresh water pump #2	440 volt	125 HP
Hot gas blower #1	2300 volt	300 HP
Hot gas blower #2	2300 volt	150 HP
Refuse pump	2300 volt	500 HP
100 motors from ¼ HP through 75 HP	440 volt	1428 HP
	Total Tipple HP	3478 HP
4161 LOADING SHOVEL		
Hoist motor	250 volt dc	187½ HP
Two swing motors	250 volt dc @ 37½	65 HP
Crowd motor	250 volt dc	37½ HP
Misc. a-c motors	220 volt ac	14 HP
	Total HP	304 HP
151-M LOADING SHOVEL		
Hoist motor	250 volt dc	225 HP
Two swing motors	250 volt dc @ 37½	65 HP
Crowd motor	250 volt dc	37½ HP
Misc. a-c motors	220 volt ac	12 HP
	Total HP	339½ HP
4121 LOADING SHOVEL		
Hoist motor	250 volt dc	125 HP
Swing motor	250 volt dc	37½ HP
Crowd motor	250 volt dc	37½ HP
Misc. a-c motors	220 volt ac	7 HP
	Total HP	197 HP
7200 DRAGLINE		
Hoist-drag motor	250 volt dc	187½ HP

(Con't)		
Swing motor	250 volt dc	40 HP
Boom hoist motor	250 volt dc	20 HP
Misc. a-c motors	440 volt ac	13 HP
	Total HP	260½ HP
40-R DRILL		
Air compressor	3810 volt	150 HP
Misc. motors	250 volt dc	35 HP
	Total HP	185 HP
5761 STRIPPING SHOVEL		
Hoist-crowd M-G set consisting of:		
1 3500-hp, 6600-volt synchronous motor		3500 HP
4 400-kw, 250-volt generators		
1 330-kw, 250-volt generator		
Swing M-G set consisting of:		
1 1500-hp, 6600-volt synchronous motor		1500 HP
3 330-kw, 250-volt generators		
Exciter M-G set consisting of:		
1 125-hp, 440-volt motor		125 HP
1 45-kw, 125-volt generator		
1 224-kw, 140-volt generator		
1 21-kw, 250-volt generator		
Hoist, swing & crowd amplidyne M-G sets		70 HP
Hoist blowers—4 @ 10 HP		40 HP
Swing & crowd blowers—8 @ 5 HP		40 HP
Oil pump motors—2 @ 3 HP		6 HP
Swing case oil pump motors—6 @ ¾ HP		4½ HP
11 ventilating fans		40½ HP
2 air compressors		13 HP
Leveling oil pump motors—2 @ 30 HP		60 HP
Steering motors—2 @ 40 HP		80 HP
Propel motors—4 @ 250 HP		1000 HP
Cable reel motor		5 HP
Jib crane motors—4		70 HP
Bearing pump motors for M-G sets—2		¾ HP
Total connected HP, stripping shovel		6554¾ HP

EPICYCLIC GEARS AND HIGH-SPEED MOTOR FOR LARGE LOW-SPEED PUMP

ROBERT SHULICK OF DE LAVAL STEAM TURBINE CO EXPLAINS THE MANY ADVANTAGES OF SMALL SIZE IN-LINE SPEED REDUCTION

LOW-SPEED electric motors are generally used for large low-speed pumps. A motor designed for higher speed would have many advantages, but would require a speed-reduction gear. The deterrent has been the question of what effect this additonal element would have on initial investment, reliability, economy, and maintenance.

Epicyclic gears show highly favorable characteristics suited to coupling in tandem with a high-speed motor for vertical low-speed pump drives. These characteristics include light weight, small size, co-axial shafts, high efficiency, and low WR^2. These are important characteristics because of their influence on the selection of the motor, design of the pump, design of support foundation, amount of required floor space, and over-all economy of operation.

Individual evaluation for each potential application, seeking justification for the introduction of additional equipment in the form of a gear and its supporting equipment, should show savings in initial investment or economy of operation, or both.

Curves in Fig. 1 show relative cost, efficiency, and power factor for typical commercially available vertical induction motors of 500, 700, and 900 hp. As the number of poles is increased, to reduce operating speed, relative cost rises while efficiency and power factor decline. When the differential becomes significant for a specific application, then the use of a high-speed motor and gear should be considered.

Although efficiency and initial cost are the most significant considerations for utility applications, power factor is also important. It is even more important for irrigation and flood control work where power is usually transmitted to the motors over long distances.

A favorable comparison between high-speed and low-speed motors is of course not the whole story. The gear and its supporting equipment, such as lubricant pumps, coolers, and filters, must also be included in the study. The effect of the gear on efficiency, cost maintenance, and the other pertinent factors must be taken into consideration.

In the horsepower range indicated by the accompanying curves, the epicyclic gear will have very little effect on over-all efficiency. Generally, epicyclic gears in this horsepower and speed range will have efficiencies of 98.5 per cent or better,

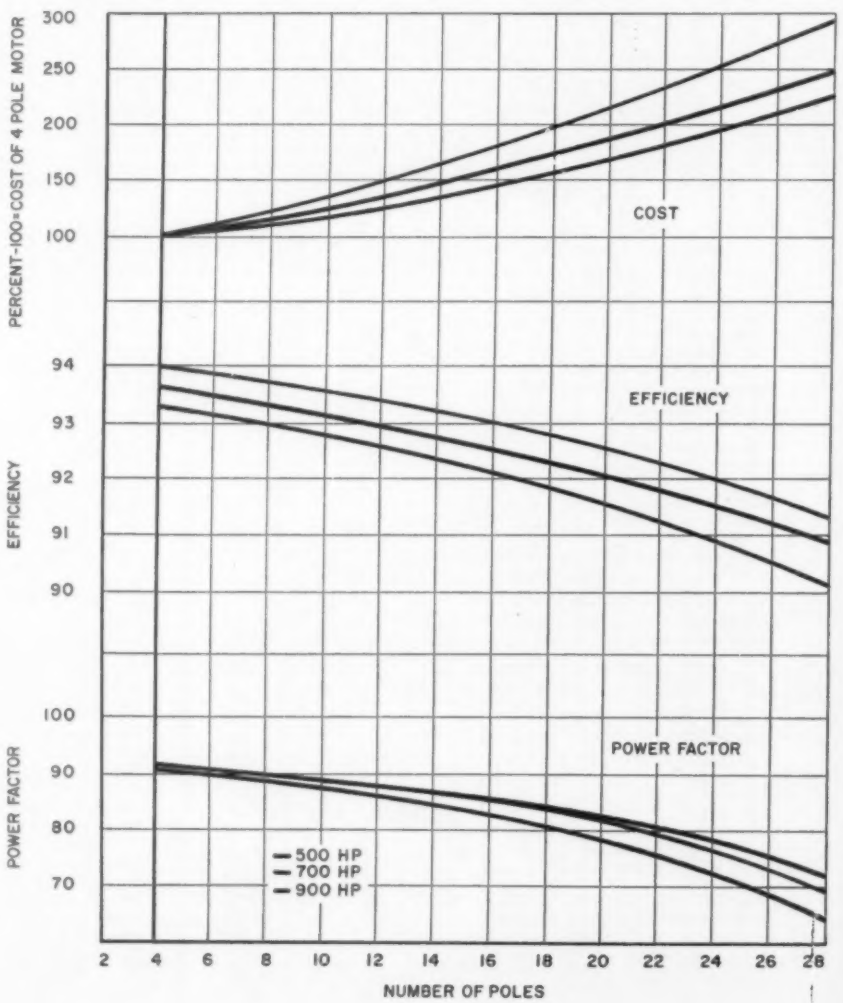


Fig. 1. Curves show how motor cost rises, and efficiency and power factor decrease, as number of poles is increased to obtain low operating speed

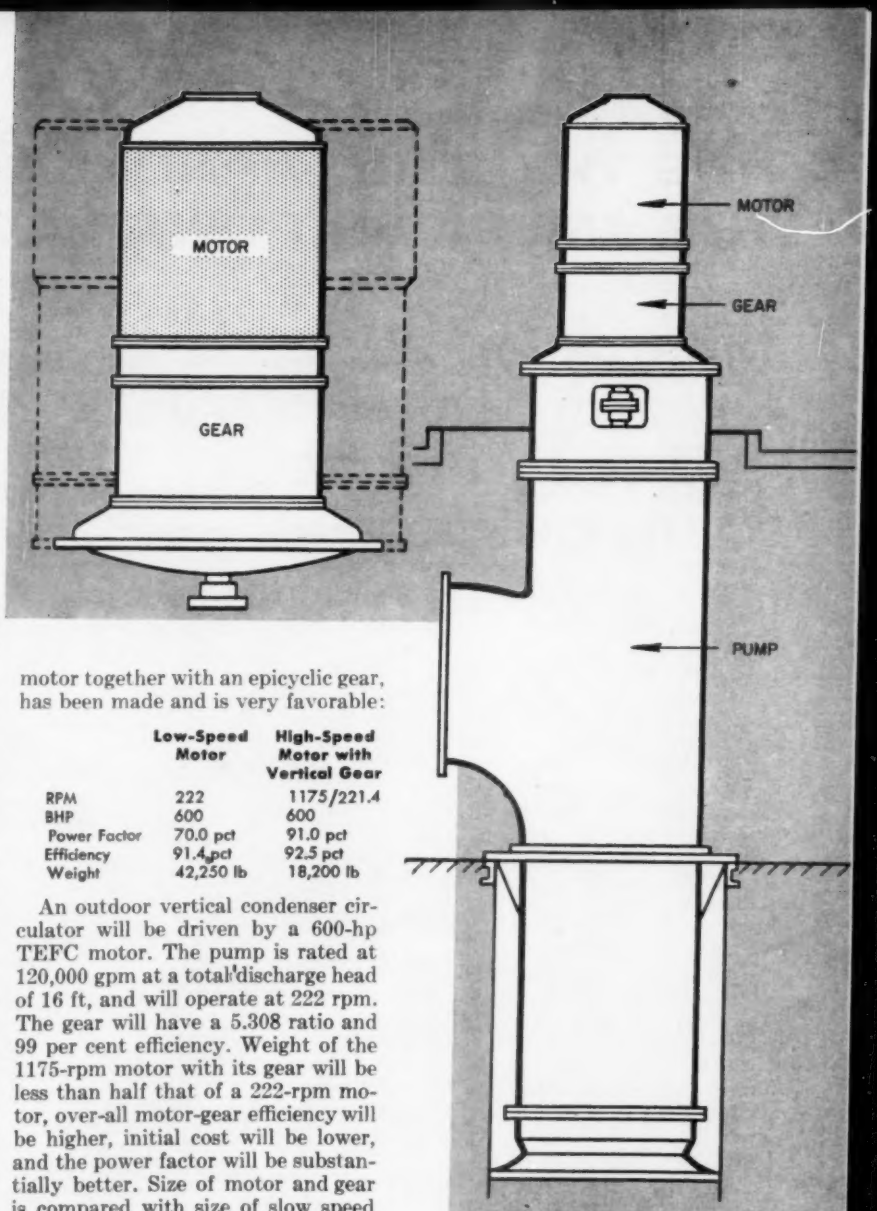


Fig. 2. Contrast in size of direct-connected slow-speed motor, and high-speed motor with epicyclic gear. Table in text shows a comparison of performance and characteristics between them

depending on torque and speed requirements. Power factor is of course not affected by the gear.

Saving in initial cost of high-speed compared to low-speed motors, is reduced by the cost of the gear and its associated equipment. On the other hand, there is the reduction of foundation and other installation costs due to the smaller size and lower weight of the high-speed motor and gear. Additionally, the pump designer is freer to choose the optimum pump speed to obtain maximum hydraulic performance, and can apply standard pump designs over a wider range, thus reducing costly design and pattern modifications.

Reliability need not be affected by the addition of the gear and its lubrication equipment. The operating experience accumulated in over 2000 successful installations of epicyclic gears of the De Laval-Stoeckicht type utilizing floating members, totaling more than 4.5 million horsepower, shows that such gears properly designed, applied, and maintained are fully as reliable as the pumps and motors with which they will be associated. (See POWER ENGINEERING, July 1959, page 79; First U.S. Planetary Gear Installation Cuts Space Requirements and Costs.)

Over-all cost of maintenance should be about the same whether or not a gear is used in these pump drives. There is an additional component to maintain, but this is counterbalanced by lower maintenance costs for a high-speed vs a low-speed motor. Such items as cleaning, checking rotor balance, and inspection of bearings require less man-hours and smaller equipment for a high-speed motor. When repairs are required, such as replacement of bearings, rewinding of coils, or replacement of insulation, they will cost less for the high-speed motor. A properly applied gear should give trouble-free service requiring only periodic inspection of bearings and teeth.

For an actual application soon to be installed, the comparison between a low-speed motor, and a high-speed motor together with an epicyclic gear, has been made and is very favorable:

	Low-Speed Motor	High-Speed Motor with Vertical Gear
RPM	222	1175/221.4
BHP	600	600
Power Factor	70.0 pct	91.0 pct
Efficiency	91.4 pct	92.5 pct
Weight	42,250 lb	18,200 lb

An outdoor vertical condenser circulator will be driven by a 600-hp TEFC motor. The pump is rated at 120,000 gpm at a total discharge head of 16 ft, and will operate at 222 rpm. The gear will have a 5.308 ratio and 99 per cent efficiency. Weight of the 1175-rpm motor with its gear will be less than half that of a 222-rpm motor, over-all motor-gear efficiency will be higher, initial cost will be lower, and the power factor will be substantially better. Size of motor and gear is compared with size of slow speed motor alone in Figure 2. THE END

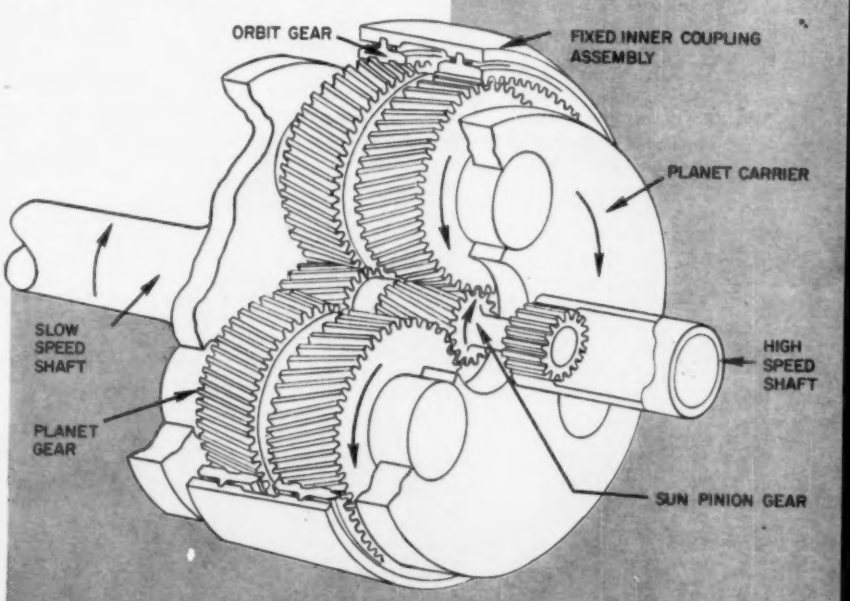


Fig. 3. Typical vertical arrangement of a high-speed motor with epicyclic gear, driving a low-speed pump. Note the symmetry of the system and lack of cantilever loads on pump casing, with one foundation supporting whole system. Right: Cutaway view of epicyclic gear

MEET YOU AT THE CONFERENCE

IT'S THE 23RD ANNUAL SESSION OF THE AMERICAN POWER CONFERENCE

TIME:

MARCH 21, 22, 23

PLACE:

SHERMAN HOTEL IN CHICAGO

LOOKED FORWARD TO as probably the most important national meeting for power engineers, this year's American Power Conference offers three days of general and special sessions which will cover just about every aspect of the profession. More than 100 papers will be given during the 31 sessions. An outline of the special interest groups is given on this page.

The conference opens Tuesday morning, March 21, in a general session presided over by Thomas Ayers, a vice-president of Commonwealth Edison Co. William F. Crawford will be the speaker. Crawford is president of Edward Valves and of Republic Flow Meters. The joint APC-ASME luncheon follows the opening session, with William H. Byrne, new president of ASME, as chairman. Sherman Knapp, president of Edison Electric Institute, will address the luncheon.

Tuesday's Evening Forum is a look-ahead session built around the theme of future sources of electrical power. Chairman will be Leonard Reiffel, director of physics research at Armour Research Foundation. R. E. Henderson of General Motors will lead off with a discussion of nuclear fuel cells research. This will be followed by a report on the status of research in thermonuclear power, given by Stirling Colgate of the Lawrence Radiation Laboratory. The third expert on the forum is C. W. Little, Jr. of the C-Stellerator Associates in Princeton, N.J., who will speak on engineering frontiers of thermonuclear power.

The APC-AIEE luncheon comes Wednesday, March 22, under Clarence H. Linder's chairmanship. Illinois state senator George E. Drach will speak on federal versus state regulation in the development of atomic power. All-Engineers dinner that evening will hear Hubert G. Ebdon, president of Combustion Engineering of New York. Master of ceremonies will be C. J. Forsberg, president of Wisconsin Power and Light Co.

Western Society of Engineers' luncheon is set for Thursday, March 23, with Titus G. LeClair of General Atomics speaking on the future of atomic energy. Raymond D. Maxson will preside.

For sponsored students and professors attending the conference there will be a tour to Dresden Nuclear Power Station on Tuesday morning.

The conference is open to everyone interested in the generation, transmission, distribution or utilization of power. Sponsor is the Illinois Institute of Technology in cooperation with nine technical societies and 14 universities. Secretary of the conference is Edwin R. Whitehead of IIT's Technology Center, Chicago 16. THE END

Quick Guide to special interest subjects to be discussed—and when—at the American Power Conference on Tues, Wed., and Thurs, Mar 21, 22 and 23

(Individuals named are chairmen of the respective groups)

Atmospheric Pollution: Thurs 2–5, Robert M. Vanduzer, Detroit Edison Co.

Automation and Control: Wed. 9–12, J. H. Kinghorn, American Electric Power Service Corp.

Auxiliaries: Thurs 9–12, Charles D. Birget, Commonwealth Associates, Inc.

Central Stations: Tues 2–5, Avon No. 8, J. H. Harlow, Philadelphia Electric Co; Wed. 9–12, Breed Plant, Philip Sporn, American Electric Power Service Corp; Wed. 2–5, Steam Generators, Chester R. Earle, POWER ENGINEERING; Thurs 9-12, sponsored by ASCE, M. P. Aillery, J. G. White Engineering Co; Thurs 2–3:30, Ben G. Elliott, University of Wisconsin; Thurs 3:30–5, Optimization and Control, Eric T. B. Gross, Illinois Institute of Technology

Computers and Network Analyzers: Thurs 2–5, E. L. Nicolson, General Electric Co.

Electrical Apparatus: Thurs 2–5, F. M. Scott, Allis-Chalmers Mfg Co.

Electrical Distribution: Thurs 9–12, G. L. Welch, Westinghouse Electric Corp.

Fuels: Wed. 9–12, James R. Jones, Peabody Coal Co.

High Voltage Transmission: Tues 2–5, W. A. Lewis, Illinois Institute of Technology.

Industrial Plants: Space air conditioning, Tues 2–5, Gilbert F. Carlson, Bell & Gossett; Electrical, Tues 2–5, W. H. Cook, Western Electric Co; Water technology, Wed. 9–12, J. F. Wilkes, Dearborn Chemical Co; Steam generators, Wed. 2–5, Chester R. Earle, POWER ENGINEERING; Training of plant personnel, Thurs 9–12, Floyd Cooper, National Assn of Power Engineers; Economics of power plant operation, Thurs 2–5, Kenneth R. Hodges, Sears Roebuck & Co.

Nuclear Power Plants: Wed. 2–5, R. M. Casper, Allis-Chalmers Mfg Co.

Peaking: Hydroelectric, Wed. 9–12, Adolph J. Ackerman; Thermal, Wed. 2–5, Rolland H. Bradford, Ebasco Services, Inc.

System Planning and Operation: Wed. 2–5, E. R. Moore, Detroit Edison Co.

Water Technology: High purity water, Tues 2–5, M. D. Baker, West Penn Power Co; Industrial, Wed. 9–12, J. F. Wilkes, Dearborn Chemical Co; Condensate polishing, Wed. 2–5, Louis F. Wirth, Jr, Nalco Chemical Co; Ion exchange, operations, Thurs 9–10:30, S. F. Whirl, Duquesne Light Co; Sea water conversion, Thurs 10:30–12, R. A. Lorenzini, Foster Wheeler Corp.

EVER SEE A PLANT BUILT?

The construction site began to shape up . . . and stack foundation steel was placed.

Four months later, forms looked like this . . .

Plus this progress on stack and steelwork.

Then a flood created this situation.

IN THE December issue of POWER ENGINEERING, we reported the dedication of Indiana and Michigan Electric Co's Breed Plant.

During the construction of this plant an excellent photographic record was kept of progressive stages of the job. These progress photos present such an interesting view of a complete plant construction program, we decided to use them — to show our readers what is involved in the building of a big electric generating plant.

Here in pictorial form, we present a number of the photos, which show some of the feats of engineering and construction in this type of project.

To obtain best condenser cooling water flow, the plant site was literally carved out of the river bed. And, to make the job tougher, a flood practically isolated the site. Good dikes and pumping facilities protected the plant area completely. It is interesting to note that during highest flood stage, the dewatering system successfully pumped a 54-ft head.

These photos give some idea of the vast quantities of structural and reinforcing steel required for such a plant. Principal uses are in foundations, boiler supports, building construction, substations and coal-handling equipment.

In addition to the plant, there was an extensive transmission line project, a railroad to a coal mine, and development of the mine itself. All of these make up the complex which delivers the electrical output of this plant into the I & M system.

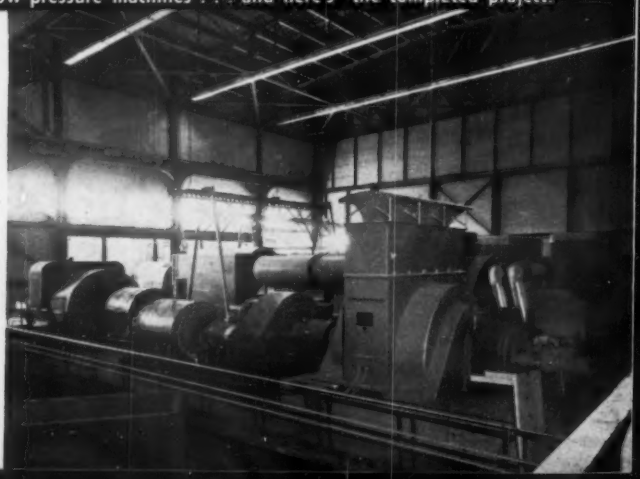
The Breed plant is located in southern Indiana, south of Terre Haute. It is part of the American Electric Power System. THE END

Steel erection is nearly complete in boiler and heater bay . . .

Coal conveyor steel goes into place . . . and coal storage pile is started. Walls of plant are now being built . . . then completed.

Here we see the turbine room floor, and the rotor being installed . . . and some of the piping and valves going into place . . .

This is a general view of the turbine room, showing both high and low-pressure machines . . . and here's the completed project.

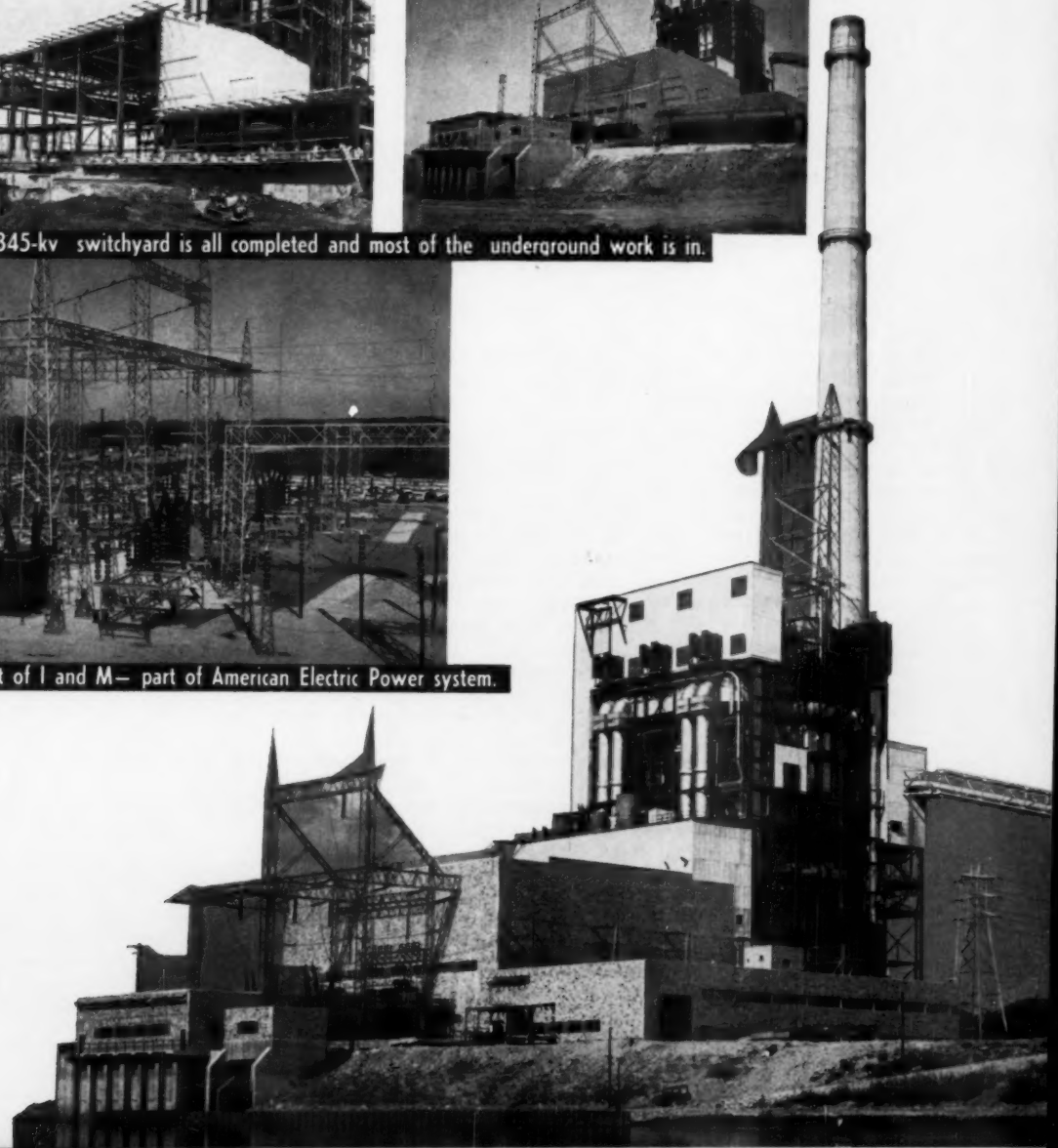


then some heavy equipment in place, and boiler erection started . . . and steel for 345-kv switchyard has been erected.

Next, the screenhouse and fire pump house are constructed . . . while the main transformer bay steel is erected.

while the 345-kv switchyard is all completed and most of the underground work is in.

the Breed plant of I and M— part of American Electric Power system.



SHOULD YOU REFRIGERATE CONDENSER CIRCULATING WATER?

MAGNUS BJORNDAL, OF TECH LABORATORIES, AND ANTON FURREBOE

SHOW HOW WASTE HEAT CAN PROVIDE A 15 PER CENT POWER BOOST

TREMENDOUS refinements and improvements in high-pressure design are utilizing the power available in the high-pressure region of the steam cycle. But this expansion is limited, and a point is rapidly approaching when more economies must be looked for in the low-pressure end of the cycle. Scant improvements have been forthcoming in this region, and these improvements remain under stringent limitations of summer temperature, of river facilities, marine life, and bacterial action as well as chemical corrosion. These limitations may reduce the efficiency of turbines from 10 to 15 per cent. In addition to this, many plants have been exposed to artificial increase of temperature of their river facilities and also to increase of corrosion effect due to adjacent industrial expansion.

Reversible flow condensers accomplish to a degree the cleaning of the cooling water surface in the condenser without resorting to costly shutdowns. Chlorination systems to some extent kill destructive marine life. Both of these systems tend to insure the highest possible heat transfer coefficient, the reduction of which today, in many instances, reduces the steam condensation capacity 15 to 30 per cent. They are, however, additional costly facilities and require continuous expense for chemicals.

Even with these refinements, the presently used system has many disadvantages such as:

A. Loss of cooling capacity, with resulting drop in vacuum, at high summer temperatures.

B. Necessity of greatly overdimensioning the entire intake and cooling system to compensate for above.

C. Necessity of periodic shutdown for cleaning purposes due to dirt and corrosion from contaminated water.

D. Up to 15 per cent drop in power output coincident with annual peak load.

E. Reduced over-all efficiency due to inability to use waste heat for useful purposes.

F. Unreliable peak power output requiring larger standby reserve capacity, thus greatly increasing investment.

To overcome these difficulties a new system has been worked out using a closed system of cooling water with artificial refrigeration. Due to the great amount of waste heat normally available, the best method is to use an absorption type system which normally is operated from the heat left in the flue gases.

To make this system more flexible and to be able to increase the capacity at the right time, it is desirable to make arrangements for use of waste heat, bleed steam from the turbine and live steam directly from the boiler, as well as a separately fired heat exchanger, where necessary. In normal operation, sufficient refrigeration is generated from the waste heat of the flue gases to supply the required cooling for the cooling water which now can be a clean-water, closed system of the proper size for normal operation. When atmospheric conditions and load demands are such that added refrigeration is necessary in excess of the amount available from the flue gases, additional capacity is available from the other sources mentioned.

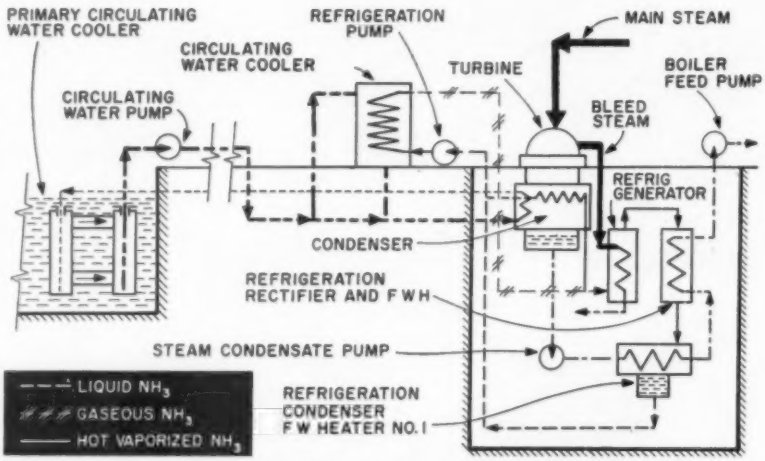


Fig. 1. Schematic arrangement of closed system for condenser circulating water and boiler feedwater, showing location of the absorption refrigerating system

It is generally stated or implied in textbooks that the second law of thermodynamics precludes obtaining any net benefit by artificially cooling condensing water. The authors of this article have obtained a patent for their method of incorporating an absorption type refrigeration system into a steam power cycle. This method purportedly reduces both first cost and operating costs, as well as providing a peak power boost. Since the benefits of such a scheme could be very great, the article is presented here as a matter of general interest.

Six Advantages

Advantages of this system are:

1. Waste heat of flue gases is recovered by using it to preheat the boiler feedwater in the system's refrigeration heat exchangers.

2. The intake house with huge revolving screens can be eliminated, and the circulating water tunnels can be greatly reduced in size, thus reducing construction cost and saving auxiliary power in pumping.

3. Greatest advantage is that peak power is available at all times regardless of atmospheric or other conditions such as high cooling water temperature. This can mean as much as 15 per cent increase in peak power when most urgently needed.

4. Clean water is used, so that shutdowns for cleaning purposes will

not be necessary. The only exposed heat-exchange surface is the outside of tubes in primary cooler, which is kept clean by automatic scrubbing.

5. The primary cooler can be made large enough to serve as condensate storage, eliminating large storage tanks and assuring low velocity and practically no temperature difference between river and cooling water, which is maintained pure and interchangeable with boiler feedwater.

6. By insuring reliable peak power, the standby reserve capacity can be utilized to a fuller extent at all times, thus reducing investment and greatly increasing the efficiency of the over-all power system.

In Fig. 1 is indicated schematically the arrangement of the closed system which uses indirect cooling from river water normally, but with added cooling from the refrigeration generated by the various means described above. Calculations show that the intake and discharge pipes of this system will be only ⅜ of the size of those for a conventional plant of the same capacity. The auxiliary cooling system shown in Fig. 1 is interlocked with the heating of feedwater for the main steam cycle as mentioned above.

Actual saving in each case can be calculated in advance and is very substantial if all factors are considered. Such calculations, made for a hypothetical installation of one turbine of 125,000 kw, indicate an approximate saving of 50 per cent in construction cost with operational advantages as mentioned above, based on cooling water temperatures naturally available of 32 degrees in winter and 85 degrees in summer.

Size of the booster cooling cycle will in each case depend upon the maximum and minimum river temperatures and the duration of these variables. Economic studies can be made in each case and will in many instances provide more flexibility to initial consideration of plant locations and to proposals for maximum use of existing water rights when extension of plants are under consideration. For existing plants where adjacent industrial developments interfere with proper cooling, impeding the full use of available power capacity, this booster cycle will pay handsome profits.

Figure 2 shows a simplified diagram of a power plant with the new cooling system, and illustrates the use of direct-contact condenser combined with the use of refrigerant coils or tubes in strategic areas of the condenser.

Although the use of a direct-contact condenser, made possible by the closed circulating-water cycle, will provide a boost in heat transfer efficiency and a reduction in cost of condenser, the system is equally adaptable to surface condensers with or without strategically located refrigeration elements.

Conclusions

Studies made to date indicate that very substantial savings can be made by introducing the new system. These include as much as 50 per cent in first cost of cooling system, and a reduction of 50 per cent in pumping power including main circulating-water system after allowance for refrigerant pump.

Use of waste heat may improve the over-all efficiency of the power plant by as much as 4 to 5 per cent, and peak power may be increased as much as 15 per cent.

Saving due to fuller use of available power capacity is intangible except for a specific system. These savings are very considerable and will increase due to the tremendous rise in hot weather loading.

This system is easily adapted to atomic steam plants by having the refrigeration exchangers use part of the reactor cooling medium as primary energy, similar to the use of waste heat in conventional plants.

Automatic plant operation, now being adopted in modern plants, can be made more exact when all heat exchange surfaces are constantly clean. THE END

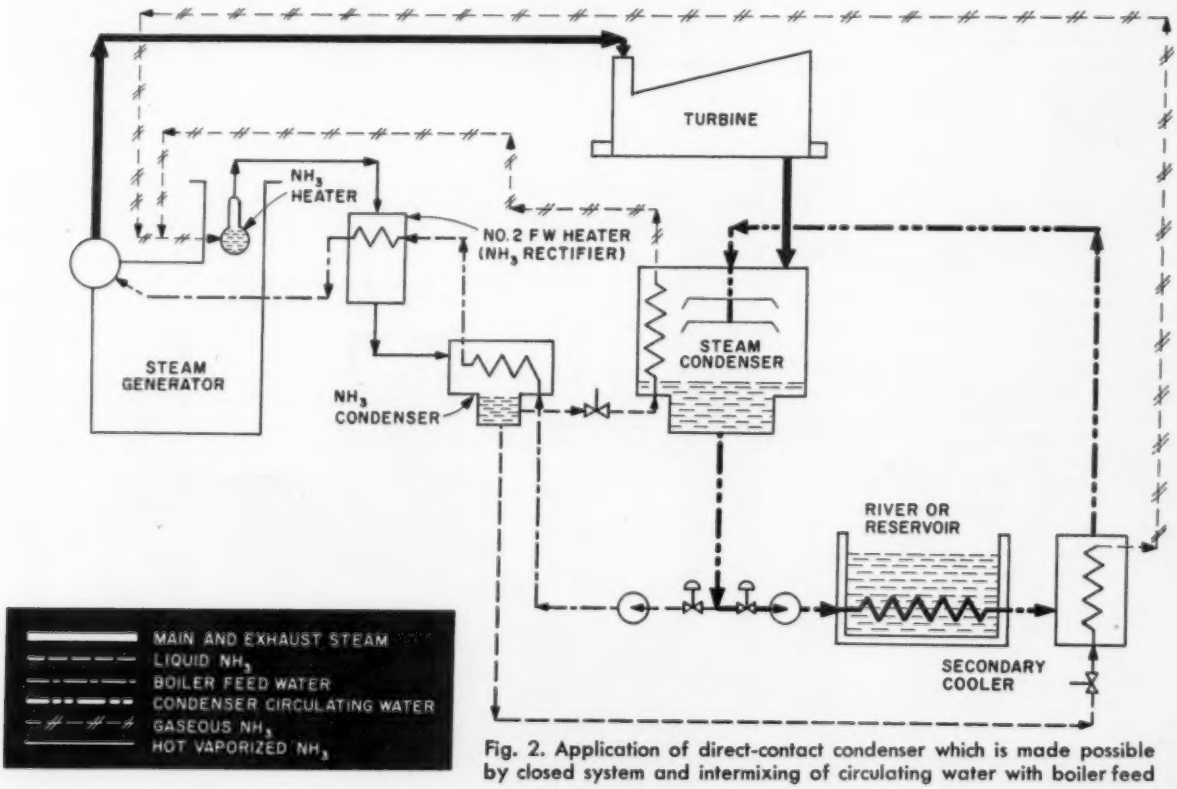


Fig. 2. Application of direct-contact condenser which is made possible by closed system and intermixing of circulating water with boiler feed

DOES PRODUCTION OF POWER POLLUTE OUR RIVERS?

BERNARD B. BERGER OF THE TAFT SANITARY ENGINEERING CENTER HERE PRESENTS THE BOLD OUTLINE OF A POTENTIAL PROBLEM THAT IS BEGINNING TO RECEIVE ATTENTION FROM THE WATER RESOURCE EXPERTS

PRODUCTION OF POWER, like many other industrial operations, may damage the quality of the water resource for further uses. The impact is sometimes indirect and often subtle, and it may seldom produce a readily visible deterioration of water quality. Yet, the effect may be appreciable. Because of the continuing steady growth of the power industry to meet the requirements of expanding population and technology, it is expected that problems of water quality will be experienced more widely by all users of water unless satisfactory remedial and preventive measures are taken.

Of particular interest are the following conditions which tend to contribute adverse effects:

1. Water to drive the turbines in hydroelectric power plants generally is taken from the lower depths of the impoundments, and may therefore be deficient in dissolved oxygen during the summer and fall months. When this occurs, the ability of the downstream water to assimilate sewage and organic industrial waste is reduced.

2. Schedules of water releases appropriate to hydroelectric power peaking operations may be out of phase with flow requirements of downstream water users.

3. Increases in stream temperatures, resulting from discharge of thermal power plant cooling waters, may in several ways hinder the stream's ability to assimilate organic wastes. Also, the heating may impair valuable aquatic life or even reduce the value of the water for further industrial use, including industrial cooling. The uncertainty of methods for predicting the rate of heat loss in a stream complicates the problem of evaluating thermal pollution.

4. The advent of the nuclear power plant has introduced a major new public health consideration, radioactivity, as a pollution problem involving the water resource. This problem represents a specialized research and control area aside from conventional power plant operations. Radioactivity will not be discussed here.

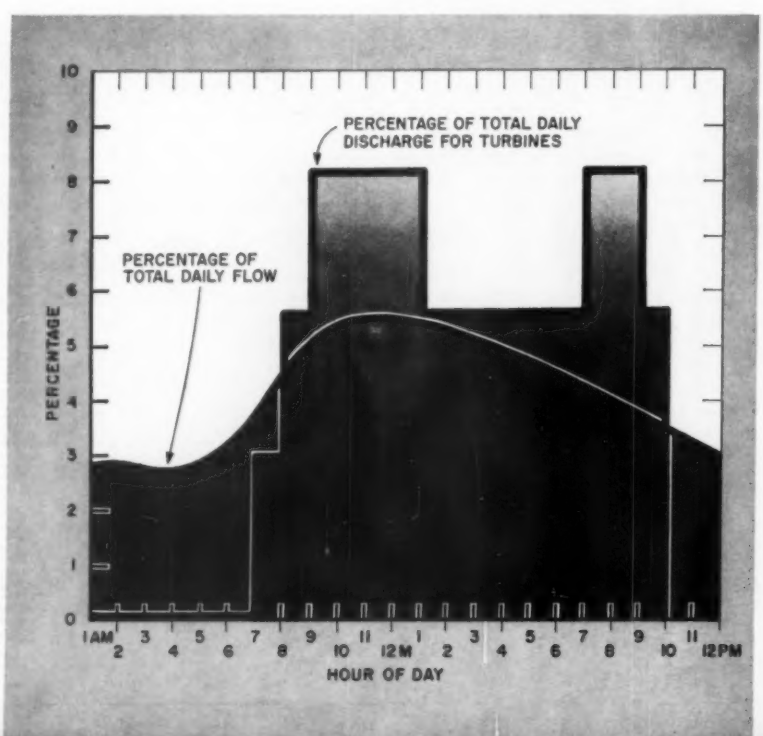
Other wastes associated with power plants have been described: domestic sewage, drainage from fuel stores, ash disposal liquid, gas washing effluent, and water treatment plant waste.[1] These are not believed to be major pollutants in the United States.

Dissolved Oxygen in Reservoir

Low-level penstock intakes in a hydroelectric power installation are used to provide maximum assurance that flow for the turbines will be available. However, water at this depth may be deficient or even completely devoid of dissolved oxygen for at least two reasons, both of which are applicable during the summer and early fall months.

First, the deep water oxygen is consumed during bacterial decomposition of settled organic matter. Second, inadequate reaeration occurs at the low depths because of thermal stratification in the reservoir. Since the ability of a stream to assimilate organic wastes depends on its dissolved oxygen content, the stream below a power impoundment may at times be defective as a waste receiver.

Reservoir discharges with dissolved oxygen levels well below normal saturation values are already common. Unless remedial action is taken, the situation may be expected to become worse, in view of the prediction that hydroelectric power will more than double in the next 20 years.[2]



Hourly variation in sewage flow and turbine peaking discharge. From Sewage Treatment by Imhoff and Fair, and based on idealized schedule of "normal" flow during the summer months

It is not surprising that interest has been aroused in the development of effective and economical corrective measures. Particular attention has been given to the feasibility of forcing air into water solution at the power turbine.[3] In a comprehensive summary of this problem Kittrell[4] lists the following possible corrective measures: multi-level penstock intakes, high-level penstock weirs, tail-race design, compressed-air reaeration, introduction of air to impoundment discharge devices, and inducement of vertical circulation in reservoirs by pumping.

An ideal system for regulating stream discharge would provide water in adequate quantity where and when it is needed. This requirement is important for communities and industries that must depend on streams to carry away and assimilate their wastes. The burden of waste disposal may be increased when additional hydroelectric power is generated to serve more industries in a stream basin.

Effects on Waste Disposal

Flow of sewage varies from hour to hour. Maximum usually occurs at or near noon and equals approximately twice the minimum flow. Discharge from a hydroelectric power dam also varies, but because of the time of flow in the stream, it is usually out of phase with the sewage flow. Cities and industries may therefore be deprived of an important part of the dilution factor when a free-flowing stream is converted to one whose discharge is dependent on a changing need for electric power.

The persistence of this effect was reported by Ingols[5] in a study below a hydroelectric dam on the Catawba River, South Carolina. He noted that a city located 12 hours or 36 hours downstream from the dam would be discharging its maximum sewage load into the minimum or night-time water discharge from the dam.

This dilution water problem is seldom acute at the present time. However, "out of phase" experience may be expected to become more extensive, since the pattern of power development in the United States favors the use of hydroelectric power for peaking purposes.[6]

A stream receiving waste from cities and industries does more than just carry the waste away. It assimilates the great bulk of organic matter, through biochemical conversion to innocuous end products. The mechanism primarily responsible for stream self-purification is microbial metabolism. In view of the possible adverse effects of high temperatures on this process, it is desirable that the discharge of warmed water from thermal power plants be studied.

Estimate of Heat Wasted to Rivers by Power Plants

	U.S. Electrical Energy Required[1] (billion kwh)	Estimate of Heat to be Rejected to Rivers[2] (billion Btu)
1958	728	1,164,000
1980	2161	3,458,000
2000	4463	7,140,000

[1] Estimate of electrical energy requirements of U.S., Federal Power Comm. Report to Select Senate Committee on National Water Resources (Comm. Rept. No. 10, Jan. 1960).

[2] It is assumed that: (a) steam plants will generate 80 per cent of total energy required; (b) 5000 Btu of heat will be rejected for each kilowatt hour of electricity generated; (c) rivers will provide 40 per cent of cooling water needed.

Some elevation of stream temperature might intensify waste assimilation. The metabolism of microbes of importance in waste assimilation appears to be most efficient at about 30 C, and the rate of reaeration is greater at this temperature than at lower temperatures. On the other hand, the saturation value for dissolved oxygen in water decreases with increased temperature.

When an excessive organic load is imposed on a stream, the dissolved oxygen may initially be consumed more rapidly than it can be replenished by reaeration. This can endanger aquatic life through depletion of dissolved oxygen, or it may even result in stream septicity. An elevation of stream temperature would aggravate this condition.

Without detailed knowledge of waste and stream characteristics, it would be difficult to predict whether a rise in water temperature would promote or retard stream self-purification in a given instance. Where the stream is already receiving a maximum organic load, any increase in stream temperature could be damaging.

Vulnerability of fish and other aquatic life to elevated temperatures represents a major restriction on the discharge of thermal power plant cooling waters. The effect may be subtle since the critical condition involves the duration of exposure in addition to the temperature level experienced. Heightened sensitivity of aquatic life to toxic substances at elevated temperatures complicates the picture. A further consideration is the apparent requirement of aquatic life for lower temperatures during winter than in summer. Data based on field observations are too scanty to permit clear-cut conclusions on the upper temperatures tolerated by fish.

It is probable that stratification of heated discharges offers fish escape routes, or a cool sanctuary at the stream bottom. A maximum temperature of 86 F measured in the zone of mixing immediately below the point of discharge is commonly accepted in Great Britain.[1]

Aquatic biologists in the United States generally support the following water temperature criteria recommended by the Aquatic Life Advisory Committee of the Ohio River Valley Water Sanitation Commission[7]: 1. the water temperature shall not be raised above 34 C (93 F) at any place or at any time; 2. the water temperature shall not be raised in streams suitable for trout propagation.

Value of water for drinking, recreational and industrial use is usually lowered with elevated temperature. This may be of considerable importance in the location of industrial plants requiring an abundant supply of cooling water. High-temperature waters containing organic nutrients may promote the development of objectionable slime or aquatic weeds.

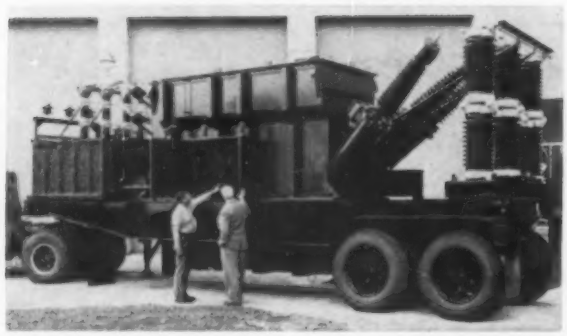
The most efficient use of the stream to dissipate excess heat requires a reliable method of forecasting the rate of heat loss. Only a few attempts have been made to develop one. The most recent[8] offers an approach based on a probability analysis of important meteorological and hydrologic variables.

Conclusion

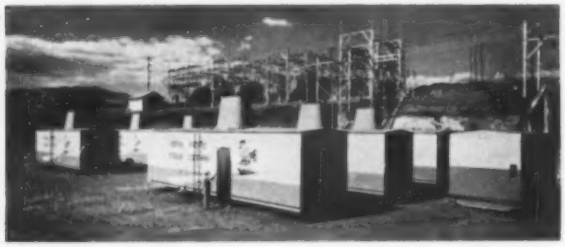
The power plant has not been considered a major threat to water quality, thus far. But with a predicted expansion of hydroelectric power capacity from 30 to 60 million kilowatts and of thermal plants from 127 to 379 million kilowatts by 1980[2], it is clear that the power industry must become increasingly concerned with protection of the water. THE END

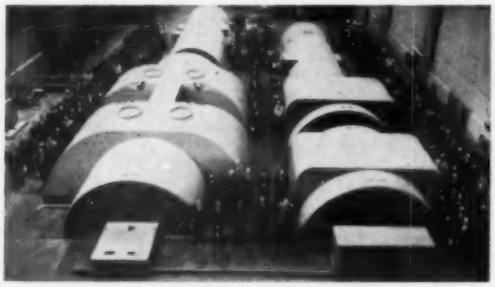
REFERENCES

1. The Operation of Thermal Power Stations in Relation to Streams. F. F. Ross. Jour. and Proc., The Institute of Sewage Purification, Part 1, p. 16 1959.
2. Electric Power in Relation to the Nation's Water Resources — Senate Select Committee on National Water Resources. Committee Print No. 10, 1960.
3. Forced Aeration of Streams by Hydro-Turbine Proves Practical. B. F. Lueck and R. H. Scott, Power Engineering, 63, 12, p. 82, Dec 1959.
4. Effects of Impoundments on Dissolved Oxygen Resources. F. W. Kittrell, Sewage and Indust. Wastes, 31, 9, p. 1065, Sept 1959.
5. Pollutional Effects of Hydraulic Power Generation. R. S. Ingols, Sewage and Indust. Wastes, 29, 3, p. 292, March 1957.
6. Technology in American Water Treatment. E. A. Ackerman and G. O. G. Lof, The Johns Hopkins Press.
7. Aquatic Life Water Quality Criteria. Aquatic Life Advisory Committee of the Ohio River Valley Water Sanitation Commission. Sewage and Indust. Wastes, 28, 5, p. 678, May 1956.
8. Forecasting Heat Loss in Ponds and Streams. C. J. Velz and J. J. Gannon, Jour. Water Pol. Control Fed., 32, 4, p. 392, April 1960.



This 25,000-kva mobile GE transformer is New England's largest, will be used by Western Massachusetts Electric Co

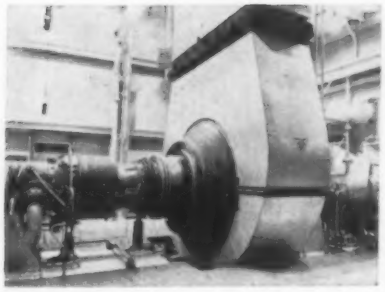




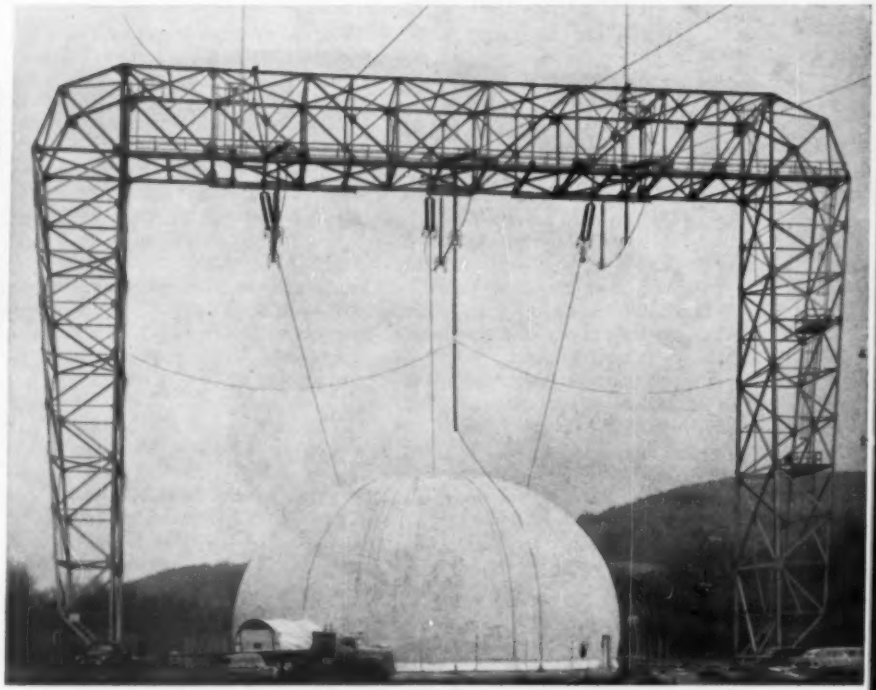
These are the men who built this first center-line-at-floor level turbine generator. It's a 275,000-kw Allis-Chalmers machine. The place is the Oak Creek (Wis.) station of the Wisconsin Electric Power Co

Country's largest block of decentralized Diesel peaking power (12,000 kw) is now in operation at Reno, Nevada, on the Sierra Pacific Power Co system. The MU-60 units were built by General Motors

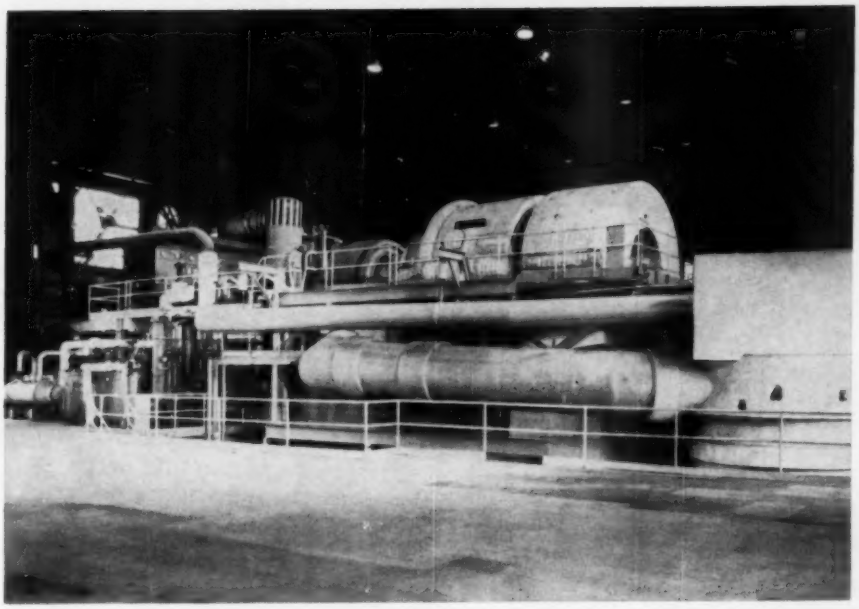
Power Engineering's



New gas turbine, the RT-248, developed jointly by Cooper-Bessemer and Pratt & Whitney, is now driving a natural gas pipeline compressor on the Columbia Gas Transmission Co line near Clementsville, Ky. It's the first of its type in U. S.

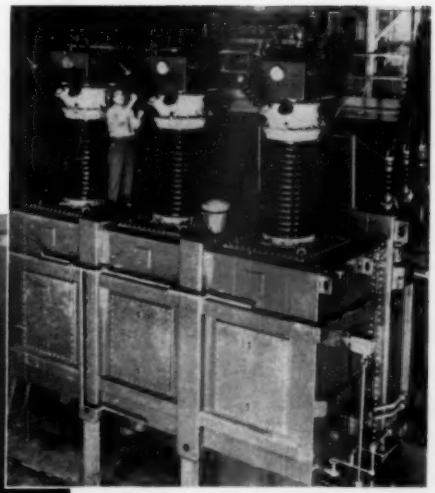


Man-made lightning of 3 million volts will shoot from within this canvas bubble and bombard the conductors at GE's Project EHV near Pittsfield, Mass. This lightning response test is one of many tests to be conducted on this experimental line



Gas-turbine driven blast furnace blower recently installed at South Works of U.S. Steel at Chicago. Designed to supply 125,000 cfm of air at 35 psig, turbine burns furnace gas from same furnaces, has had successful test run

NEWS REEL



This 200-mva power transformer with resistance-switched high-voltage load tap changer goes to Gardenville station of N.Y. State Electric & Gas. Westinghouse made it. This type of load tap changer reduces length, makes unit 10% lighter

Thermoelectric generators for industrial and commercial applications are available from Westinghouse. These four units in ratings of 5, 10, 50 and 100 watts are typical. They are completely static, have low voltage, high current d-c outputs (static inverters or converters are available), can be designed to combine any type of fuel and any cooling medium

BACKWASHING THE CONDENSER

WHY SHOULD BACKWASHING SYSTEMS BE USED ON SURFACE CONDENSERS?

A. J. BRAUN OF ALLIS-CHALMERS EXPLAINS BOTH WHY AND HOW

LET'S CONSIDER the condenser vacuum. This vacuum is dependent on the effective transfer of heat from the exhaust steam to the water, which depends on the temperature, quantity, and quality of the inlet water.

When the water is from a natural source such as a lake or river, its temperature is determined by the laws of nature and its quality by local and seasonal conditions. At some locations the water may contain silt which is carried into the condenser with the circulating water and tends to settle out and fill up the bottom of the water box and the lower tubes.

At other locations the water may be polluted with leaves, twigs, plant foliage, small stones, small fish or various other types of debris which pass the screens and enter the condenser with the circulating water. This tends to mat up against the face of the tube sheet and plug the tubes, consequently reducing the quantity of water which can be passed through the condenser. Thus under such conditions corrective measures must be used or serious performance decrease will result.

Backwashing is the reversal of water flow through a condenser, to keep the water circuit clear and free of tube plugging due to dirty or polluted circulating water. Correctly designed backwash or reverse flow system will provide the required corrective flushing action to maintain an open water circuit in the condenser while the unit is operating and thus avoids the frequent costly shutdown which would otherwise be needed to open the condenser and carry out the necessary cleaning.

So, backwashing provides an easy and economical method of helping to keep the condenser in continuous operation and maintaining highest vacuum to allow the turbine generating unit to operate with the best water rate and efficiency for long uninterrupted periods.

Two major benefits will result from a consideration of various backwashing systems. First, a knowledge of some of the basic factors involved allows studies enabling a desired system to be more adequately specified. Secondly, from a knowledge of these factors and an analysis of several of the schemes presented, an idea of a system most suitable for a particular situation can be obtained. Selection of the exact system would, however,

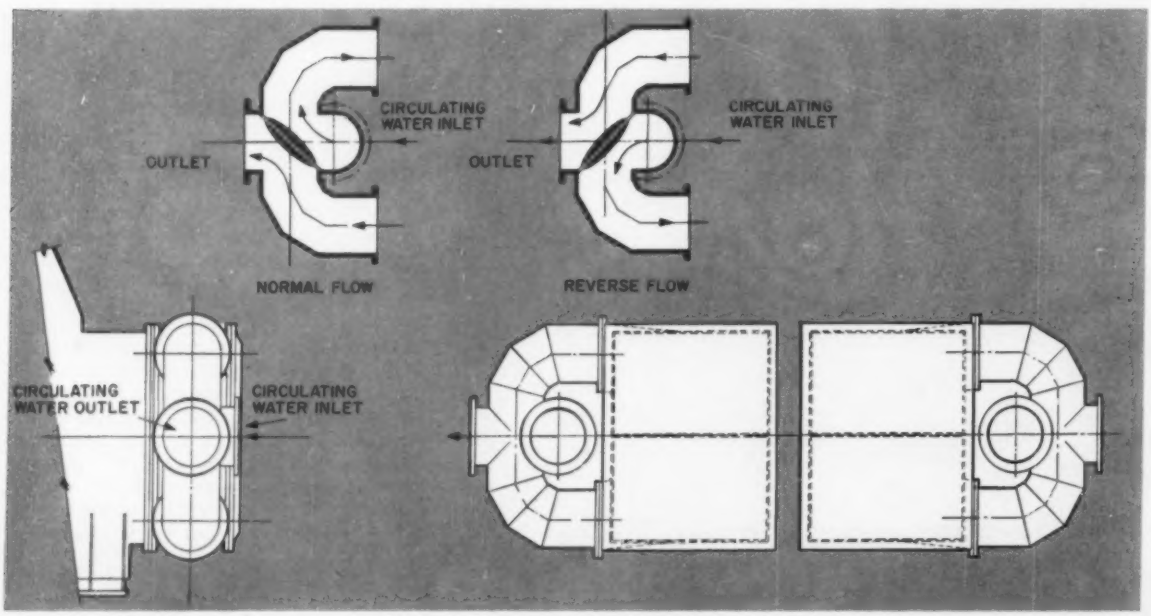


Fig. 1. An external backwash system on a two-pass divided water box condenser using cross-flow butterfly valves

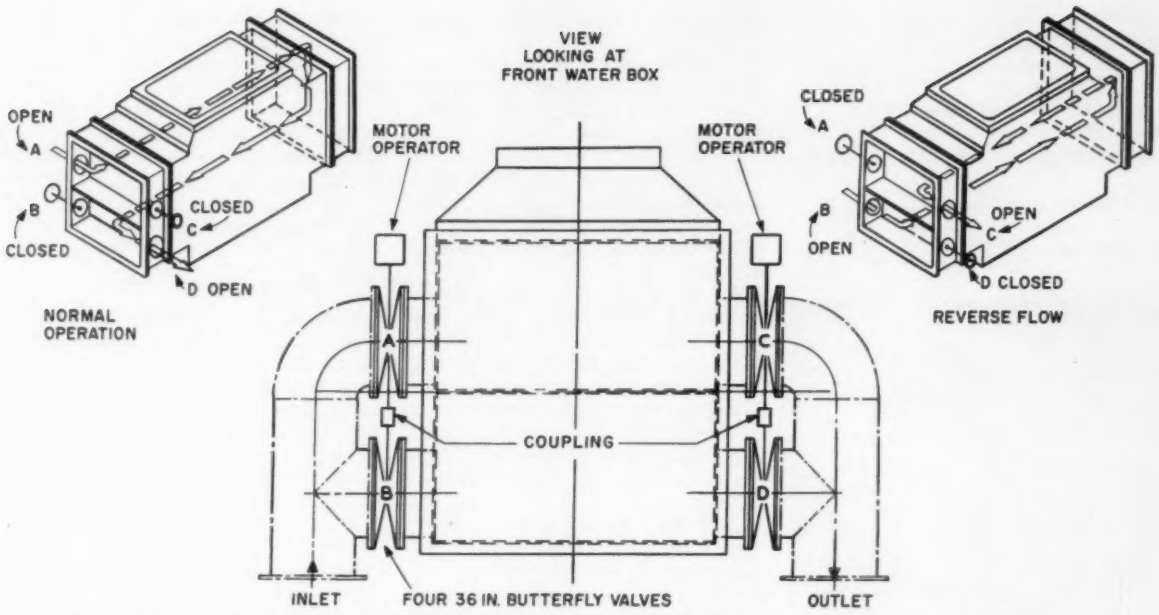


Fig. 2. System with a two-pass non-divided water box condenser using external butterfly valves. In normal operation valves A and D are open, B and C closed. For reverse flow, the motor operators close valves A and D, open valves B and C

probably be made after a more thorough engineering investigation.

Question arises as to when backwashing is required. The need for cleaning will make itself apparent by an increase in pumping head due to increased condenser friction loss because of plugged tubes, and an accompanying drop in condenser vacuum because of the reduced quantity of water flow through the tubes and the loss of the condensing surface of the plugged tubes. The intervals between backwashing periods are determined by local conditions, and the length of time allowed for the backwashing process depends on the type of debris peculiar to that location. Time needed for removal must be established by trial or experience in each case.

At some locations backwashing may only be necessary during certain seasons of the year due to falling leaves or some other seasonal condition. At locations where water pollution is fairly constant throughout the year a continuous schedule may be set up for backwashing, and a timed automatic arrangement can be designed using time sequence controls to open and close motor-operated valves as required at predetermined time intervals. After a set time of backwashing, the required valves are again operated automatically to return the water flow to normal operation.

Although there are many different backwashing system arrangements, in several the distinction can be made as to whether "external" valves or "internal" valves are used. Sometimes, however, the two types may be combined. External valves are of the butterfly type, and they are installed in the circulating water lines external to the condenser.

In contrast to this, internal valves operate on the butterfly principle but are installed in the dividing wall of a water box. Operators may be mounted on the water box covers, or at the top, bottom, or side of the water box.

Butterfly valves are popular for backwashing service because of low friction losses, freedom from plugging, and ease of installation, operation, and control. The valves can be for manual, electric motor or hydraulic operation.

Arrangements using external valves to reverse water flow have been used for many years and are still often used as best suited for certain installations. In recent years, internal systems have become popular because of simplicity of operation and because of less installation space required since the valves are inside the condenser water boxes. Cost for internal systems are also usually slightly less.

Using External Valves

Figure 1 shows an arrangement for backwashing a two-pass divided water box condenser by means of external reversing valves. For a non-divided water box type of condenser only one reversing valve is needed. In one form or another this type of arrangement has been in use for 25 years or more and is still often applied today. The valve can be installed in the piping at a remote location. It may be any one of several different types: a four-way plug type; a moving elbow type, such as the MacNeal design; a sliding sluice gate type; or a butterfly type. The valves can be designed for manual operation or

Fig. 3. This external system is unique in that water box connections are all on cover

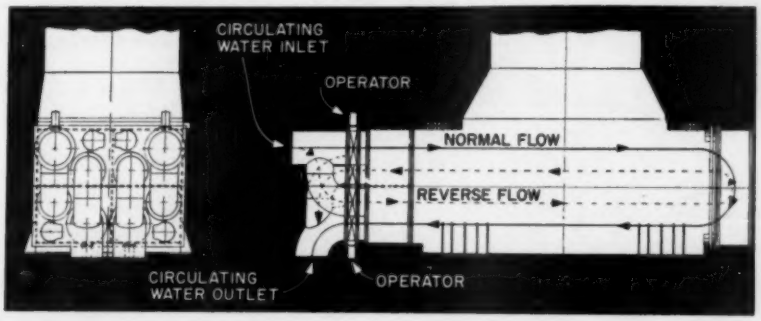
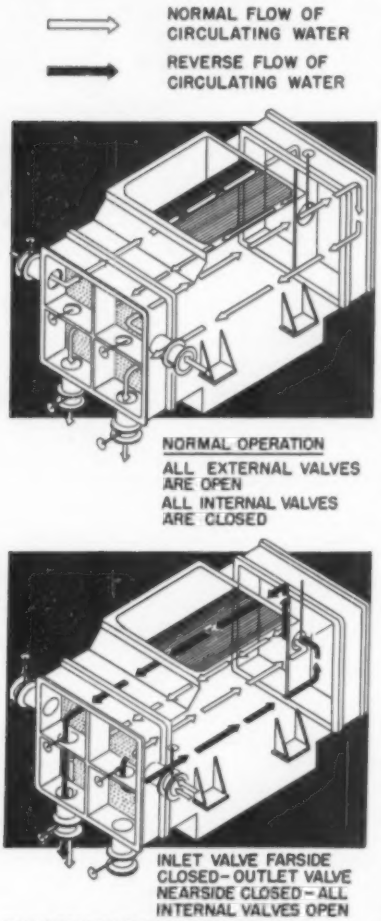


Fig. 4. Internal backwash system that has become popular during the last ten years. Two-pass divided box is shown


NORMAL FLOW OF CIRCULATING WATER
REVERSE FLOW OF CIRCULATING WATER
NORMAL OPERATION
ALL EXTERNAL VALVES ARE OPEN
ALL INTERNAL VALVES ARE CLOSED
INLET VALVE FARSIDE CLOSED–OUTLET VALVE NEARSIDE CLOSED–ALL INTERNAL VALVES OPEN
THIS RESULTS IN BACKWASH OF UPPER FARSIDE AND LOWER NEARSIDE
INLET VALVE NEARSIDE CLOSED–OUTLET VALVE FARSIDE CLOSED–ALL INTERNAL VALVES OPEN
THIS RESULTS IN BACKWASH OF UPPER NEARSIDE AND LOWER FARSIDE

have electric motor or hydro-motor operators.

The water enters at the front nozzle on the valve and discharges at the other nozzle on the valve. For normal operation the valve disc is set to direct flow to the top half of the water box, or first pass, and then after making a turn in the back water box it comes through the bottom, or second pass, and discharges through the valve.

For backwashing, the valve disc is moved 90 degrees and directs the inlet water to the bottom half of the water box. The water flows to the back box in reverse direction from normal and then comes back through the upper pass in reverse flow direction and leaves the condenser through the valve to the discharge pipe line. Thus full reversal of flow is accomplished for one-half the condenser. The other half is operated in the same manner and can be fully automatic.

Figure 2 shows a two-pass non-divided water box condenser. It has four butterfly valves, two at the inlet having a common operator and two at the outlet with a common operator. One inlet valve is always open and the other is closed. Likewise, at the outlet one valve is open and the other closed.

How It Works

For normal operation the valves direct the inlet water to the upper, or first pass, and then after making a turn in the back water box, the water returns through the lower, or second pass, leaving through the lower open outlet valve. For reverse flow the motor operators close the above mentioned two valves and open the opposite two valves. This directs the inlet water through the bottom pass first and it leaves through the top pass, thus causing complete reversal of water flow.

This is a simple and compact arrangement and can be made a fully timed automatic set-up or can be push-button-operated from a control panel.

Figure 3 shows a two-pass 40,000-sq ft divided water box type condenser using a compact and unique system employing four sets of dual butterfly valves. Each set of two valves has a common operator which opens one valve while the other is closed. Special manifolds are installed ahead of the valves.

For normal operation the upper inlet valves and the lower outlet valves are open causing the water to flow through the upper pass and turn in the back box and then return through the tubes in the lower pass and discharge through the open outlet valve. For backwash, the operators close the above valves and open the opposite valves causing the water to flow in reverse direction.

This is a very successful system, and the debris removed by the backwash is flushed downward to the outlet duct. This arrangement can usually be incorporated in a piping system layout without difficulty because very little extra space is needed.

Using Internal Valves

Systems using internal valves are illustrated in Figs. 4 and 5. Systems shown are considered internal systems because even though external valves are present, they serve only as shut-off valves, and the internal valves are required to perform the backwashing function. The external valves would be present as shut-off valves without the backwashing feature.

Figure 4 shows an internal backwash system which has become very popular during the last ten years. A two-pass divided box is shown. It requires seven butterfly valves, one at each water nozzle and two in the horizontal wall of the front box and one in the vertical wall of the back box.

During normal operation all internal valves are closed and all four external valves are open. For backwash the three internal valves are opened and one external inlet valve and one external outlet valve are closed. Backwashed areas are indicated by the solid arrows. Half of the condenser (opposite quarters) is backwashed at one time. Flow is always downward and, therefore, debris is easily and effectively flushed out to the discharge duct.

Figure 5 shows a pioneer design which was first used about nine years ago in a 100,000-sq ft condenser. This design is unique, because by means of the valve arrangement the condenser can be operated as a single-pass or a two-pass unit, and it can also be very effectively backwashed. It will be noted that a butterfly valve is used in each water box dividing wall, and an external butterfly valve is used at each water box nozzle.

For normal operation as a single-pass unit, the division wall valves are closed and the water enters at opposite ends, flowing through the condenser in separate channels formed by the dividing walls and discharging at opposite ends. For backwashing, the valves in the dividing walls of both boxes are opened and one inlet and one outlet external valve are closed, reversing the flow in one-half the tube nest as shown by the shaded portion. To operate this condenser as a two-pass unit, the valve in the di-

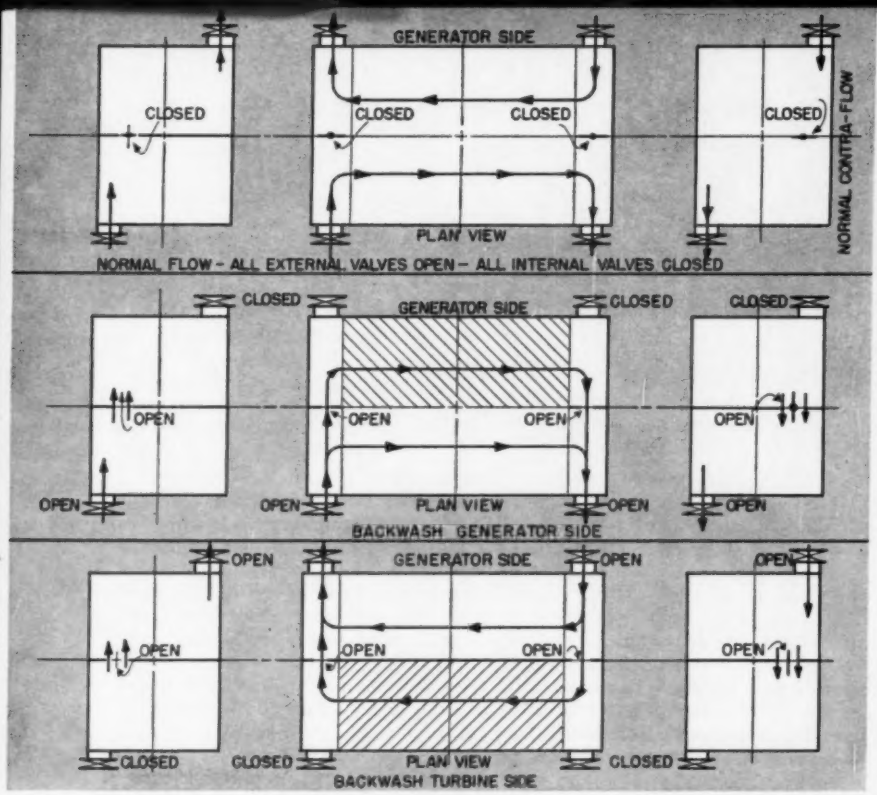


Fig. 5. This system allows backwashing, and condenser may be operated either as single or 2-pass unit (often desirable)

viding wall of the box at one end is opened and the two external valves on that box are closed.

This feature can be used at locations having periods of water shortage at certain times of the year due to changing river levels or other reasons. By operating as a two-pass unit instead of a single-pass unit during these periods of reduced water quantity, a more practical and higher water velocity through the tubes is obtained with a correspondingly better heat transfer rate.

Combination

There have been occasions when a condenser was installed at a location where water was assumed to be of good quality but later, due to unforeseen conditions, tube-plugging problems developed which made it necessary to add a backwashing system to avoid frequent shutdowns for cleaning.

A midwest utility has two power plants which have always enjoyed excellent water conditions, and neither plant was ever troubled by trash of any kind to cause tube plugging. About eight years ago the company decided to build a new plant a few miles south of their other plants and also on Lake Michigan. They had every reason to assume that water conditions would be equally as good as at their other two plants. Shortly after the first unit was put in operation tube-plugging trouble began.

An inspection showed that plugging was caused by small pieces of animal hide and hair, and an investigation revealed that many years ago a tannery had been dumping this type of waste matter into the lake. Apparently large quantities had pocketed in a large area in the lake off shore from the plant, and were drawn into the intake tunnel and passed through the screens, severely plugging the tubes.

All efforts to screen out this trash failed and a study was made to determine how a backwash system could be added.

Figure 6 shows, in the upper view, the design of this condenser as it was built and installed. It was a single-pass non-divided type having two inlet water nozzles and one large discharge nozzle. Lower view shows how the backwash feature was accomplished. This scheme is called a combination system because both the external valve and the internal damper that were added are required to accomplish the backwashing function desired.

Required changes and additions were made at the plant site during a brief shutdown. Vertical division wall was welded into the inlet water box as well as two valved outlet water nozzles. Damper valve was installed in the discharge nozzle of the outlet box. Using the damper in the discharge nozzle and proper operation of the other four valves, a two-pass flow is obtained which backwashes the shaded portion very effectively. This field installation was made on the condenser for the first 125-Mw unit. Three other 125-Mw units had the backwash feature installed at the factory, and a 159,000-sq ft condenser for a 250-Mw unit also has the same successful style of backwash system. THE END

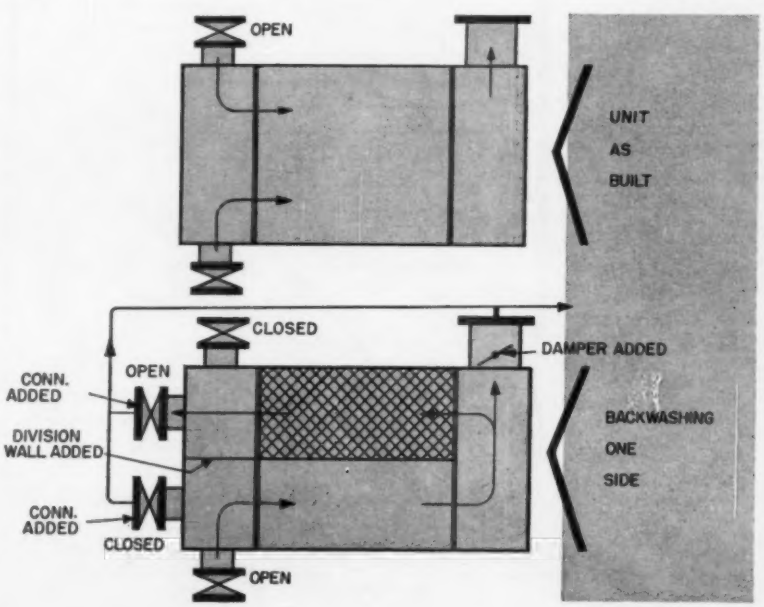


Fig. 6. Due to conditions found after installation, this unit was given a backwash system during scheduled outage

SEWAREN'S NO. 5 UNIT USES NEW TURBINE BLADE DESIGN

WESTINGHOUSE DESIGN ENGINEER D. R. COBB TELLS HOW NEW LONGER BLADES MAKE LARGER TURBINES PRACTICAL

RAPID GROWTH of electric utility systems and formation of "power-pools" have resulted in significant increases in turbine generator ratings. This trend will continue. Figure 1 shows graphically the growth in average unit sizes and maximum unit sizes over the past ten years. It also indicates what we may reasonably expect in future turbine-generator sizes.

Substantial changes will occur in initial steam conditions and in the application of multiple reheat as unit capabilities continue to push upward. New and complex problems challenge the designer's imagination. No less challenging is the problem encountered at the exhaust end of the turbine where the large volumetric flows must be given careful consideration to maintain the high efficiency required in the modern steam power plant.

Volumetric flow through the low-pressure turbine exhaust is a function of electrical load, condenser back-pressure, initial steam conditions, and cycle arrangement. Specifically, it is the product of the exhaust steam flow (pounds per hour) and the specific volume (cubic feet per pound). A typical large turbine-generator unit operating at 300,000 kw and exhausting to a vacuum of 28½ inches of mercury will pass a volumetric exhaust flow of 174,000 cubic feet every second.

Velocity of steam exiting from the last row of blading is controlled by the exhaust annulus area and constitutes a direct energy loss (leaving loss). Additional energy loss will occur if the exit velocity is permitted to reach critical values — for under this condition a blade exit pressure proportional to the exhaust mass flow is established. The result is a further reduction in the amount of available energy which can be converted into work in the blading.

Economic considerations determine the exhaust annulus area practical to satisfy specific conditions. There are two means of fixing the exhaust area:

1. By last-row blade length.
2. Compounding low-pressure ends.

Selection of the optimum turbine arrangement is always undertaken jointly by the purchaser (or his representative) and the manufacturer. Many factors must be studied and evaluated. Major considerations are turbine-generator costs, foundation and building costs, fuel costs, and equipment arrangement.

Figure 2 illustrates a line of 3600-rpm turbine-generator arrangements. Obviously, the number of exhausts has a significant bearing on the complexity of the turbine-generator construction. Likewise, turbine-generator construction affects the over-all arrangement of the power plant.

Until recently, last-row blades were available in lengths of either 23 inches or 25 inches for large units. The blades were mounted on a disc having a diameter of approximately twice the blade length. A new 28-in. blade will now be built for tandem arrangements of double-flow and quadruple-flow and, in the cross-compound construction, it will be employed on quadruple-flow and octuple-flow designs.

Development of 28-in. Blade

Development of the 28-in. blade was undertaken approximately three years ago in an effort to simplify construction by the use of fewer exhaust ends, and to facilitate the building of larger ratings in the 3600-rpm class. Successful completion of rotating tests on the prototype blades has now cleared the way for commercial production.

First turbine to employ this new blading will be installed in the Sewaren Generating Station (Unit No. 5) of Public Service Electric and Gas

Fig. 1. Growth patterns and projections of average and maximum unit sizes

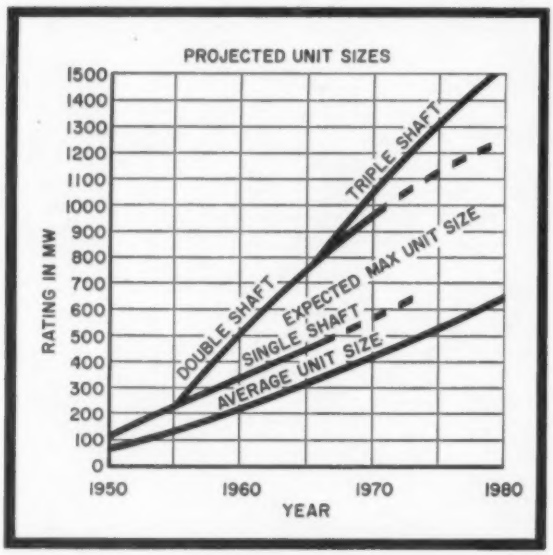
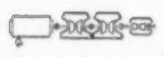


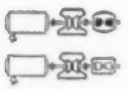
Fig. 2. Arrangement of 3600-rpm Turbine Elements

Tandem Compound Double Flow

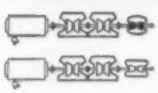


Tandem Compound Quadruple Flow

Tandem Compound Quadruple Flow



Cross Compound Quadruple Flow



Cross Compound Octuple Flow

Company. A look at the background of the Sewaren turbine illustrates the real benefits obtainable from the use of longer last-row blading.

Sewaren 5 is rated 342,000 kw. Initial steam conditions are 2400 psi, 1100 F. Reheat temperature is 1050 F, and the design back-pressure is 1.25 in. of mercury absolute.

Six low-pressure ends using 25-in. long last-row blades were originally selected to obtain the required exhaust area. The turbine would have been a six-cylinder, cross-compound, sextuple-flow design illustrated in Figure 3.

Development of the 28-in. blade was progressing well, and it became apparent that the new blade could be employed on the Sewaren turbine without delaying shipment. At a joint review by Public Service and the author's company, the decision was made to revise Sewaren 5 to a cross-compound, quadruple-flow machine with 28-in. blades. Figure 4 illustrates the design as it is being built.

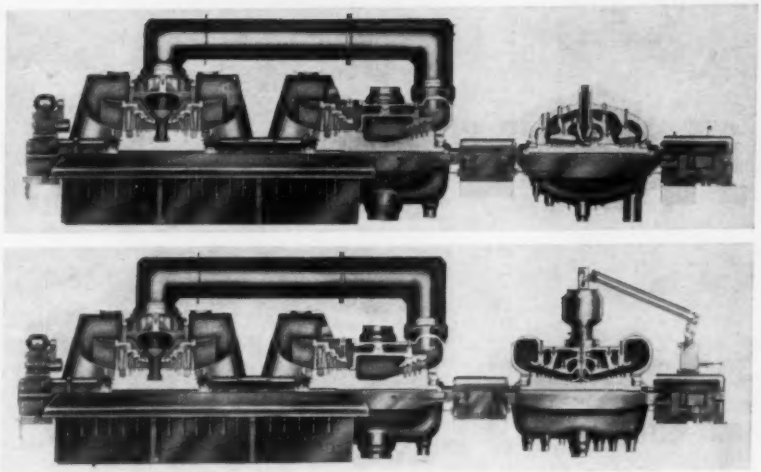


Fig. 3. Illustration shows a six-cylinder, cross-compound, sextuple-flow design

Elements of the Design

This design consists of the same high-pressure elements as used in the sextuple design. The intermediate-pressure section is similar to the sextuple intermediate except that the blading of the low-intermediate section of the sextuple design is incorporated into the intermediate-pressure and low-pressure sections in the "quad" design. Cross-over pipes connect the intermediate-pressure and low-pressure elements.

Changeover from six 25-in. ends to four 28-in. ends resulted in a reduction of exhaust annulus area of approximately 16 per cent and a small impairment in turbine heat rate. The additional fuel cost required per kilowatt-hour of generation was justified by the savings realized from the change:

1. Savings due to turbine price differentials alone amount to $500,000.

2. Foundation and building cost savings will vary depending on indoor versus outdoor units. At Sewaren, one wall of the turbine hall is located between the turbine and generator — the turbine being indoors and the generator outdoors. The reduction in turbine length was 18 feet, and the savings in foundation structure and building costs were between $100,000 and $150,000.

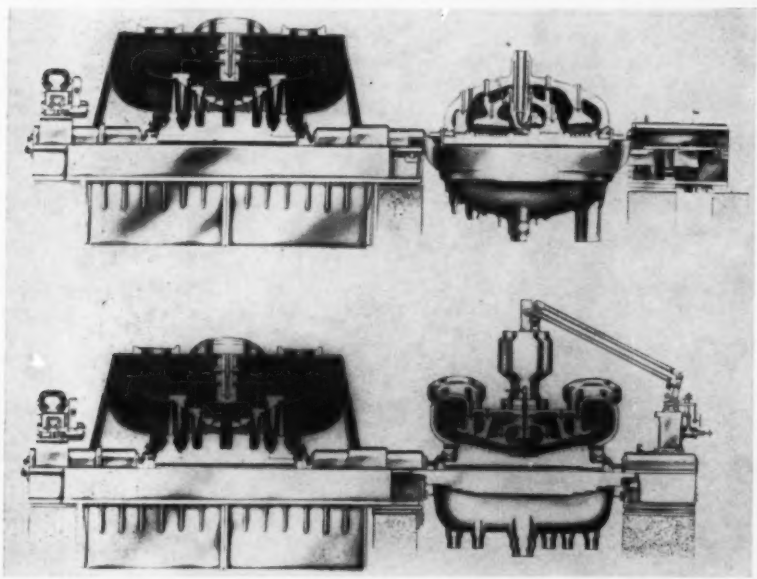
3. Design and installation costs are reduced due to the elimination of cross-under pipes. On Sewaren the cross-under piping consisted of four 30-in. pipes — two to each low-intermediate pressure cylinder.

4. Erection time and costs will be appreciably reduced by virtue of four cylinders versus six. The same is true of maintenance time and costs.

Development of the 28-in. blade is a significant engineering accomplishment when one considers the mechanical aspects which must be satisfied while still retaining a blade configuration having high thermal efficiency. Each 28-in. blade produces a centrifugal force of 160,000 pounds when revolving at 3600 rpm. The blade fastening area has been so designed that the stresses occurring in the blade fastening are no greater on the 28-in. blade than on the 25-in. blade. The blade is carried on a curved serrated root similar to the 23-in. and 25-in. blades, but having a wider platform.

The new low-pressure end is an important step forward in the art of turbine design. It will contribute to simplified, more reliable turbines, with improved efficiency. It makes reasonable 3600-rpm turbine designs for capacities up to 1,000,000 kw. This new blade is quite probably the longest which can be made from the presently available materials. The search for new and improved materials will continue in an effort to build larger low-pressure ends. The dotted portions of the curves, Fig. 1, indicate the unit capabilities which may be expected in 3600-rpm units for the single shaft and double shaft units if progress in last-row blade length continues to be made at the same rate as has been established in the past. THE END

Fig. 4. Design of cross-compound, quadruple flow Sewaren 5, as it is built



EHV
460kv

PENELEC'S EHV POWER PROJECT

PENNSYLVANIA ELECTRIC COMPANY STARTS

OPERATION OF NATION'S FIRST 460-KV LINE

Fig. 1. One of the heavy-duty steel suspension towers which were detailed, fabricated, and galvanized by Bethlehem Steel. Leg extensions are provided at corners of all towers to compensate for sidehill conditions

RECENTLY, the Pennsylvania Electric Company, better known as Penelec, energized one of the highest voltage transmission lines in the United States. This was a joint venture, so to speak, in which a number of manufacturers participated. Since the line was to be a research project, a number of different types of equipment were utilized.

Operating voltage on the line is 460 kv. The supporting structures are wood, metal, and laminated wood. Tubular metal towers have also been used.

Four different types of conductors have been built into the line. Three of these are bundled type, and one section is single conductor. The towers range in height from 60 to 130 feet.

Special transformers designed for 460 kv are installed at both ends of the line. At one end there is a three-phase transformer, and at the other end three single-phase units are employed.

The line was designed by Penelec engineers, assisted by engineers from the supplying companies and from West Penn Power Company and Metropolitan Edison Company. This experimental line extends from Claysburg to Saxton, Pennsylvania.

Manufacturers who contributed both material and engineering talent were Bethlehem Steel Co, Hughes Brothers, Inc, Rilco Laminated Products, Union Metal Manufacturing Co, Aluminum Co of America, Preformed Line Products Co, Kaiser Aluminum & Chemical Corp, Copperweld Steel Co, General Electric Co, Ohio Brass Co, I-T-E Circuit Breaker Co, and Pennsylvania Transformer Div, McGraw-Edison Company. Line construction was performed by two companies — Day & Zimmerman, Inc and Sordoni Construction Co.

This project is certainly another milestone in the advancement of EHV in the United States. All participants are to be highly congratulated on their efforts in this project.

THE END

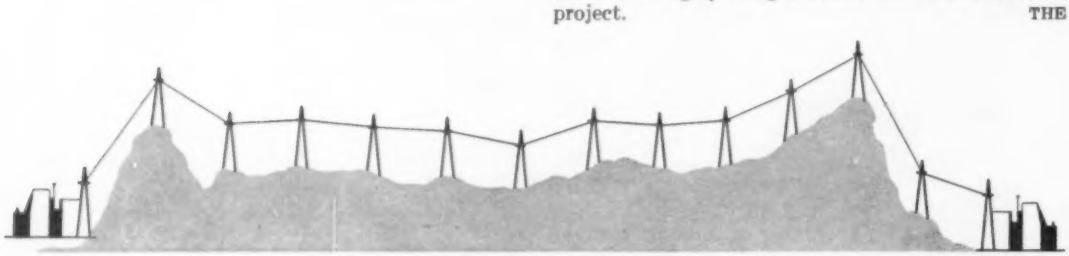
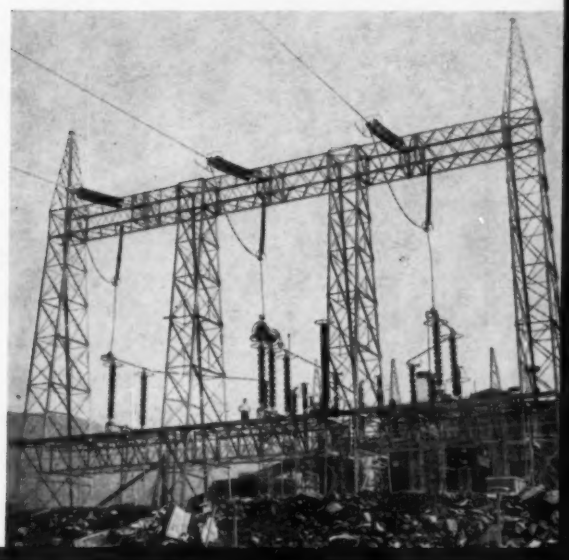
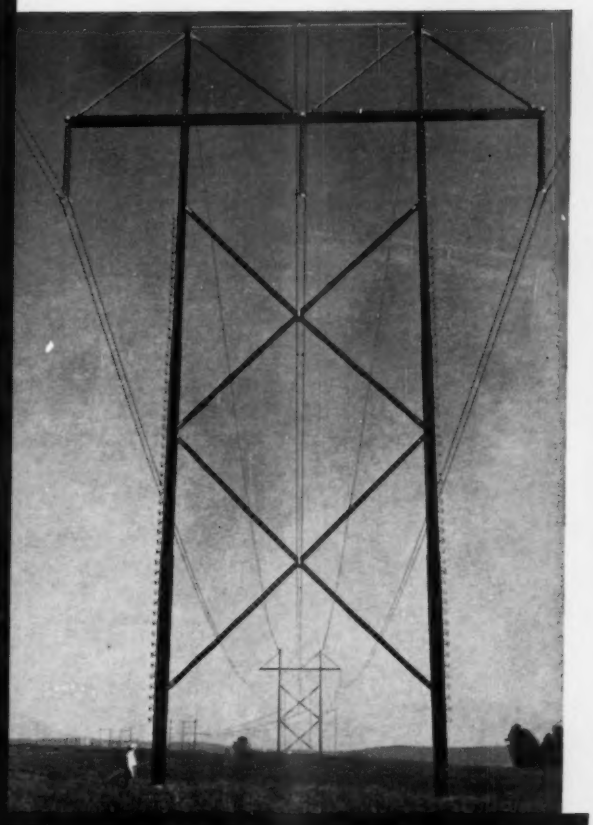


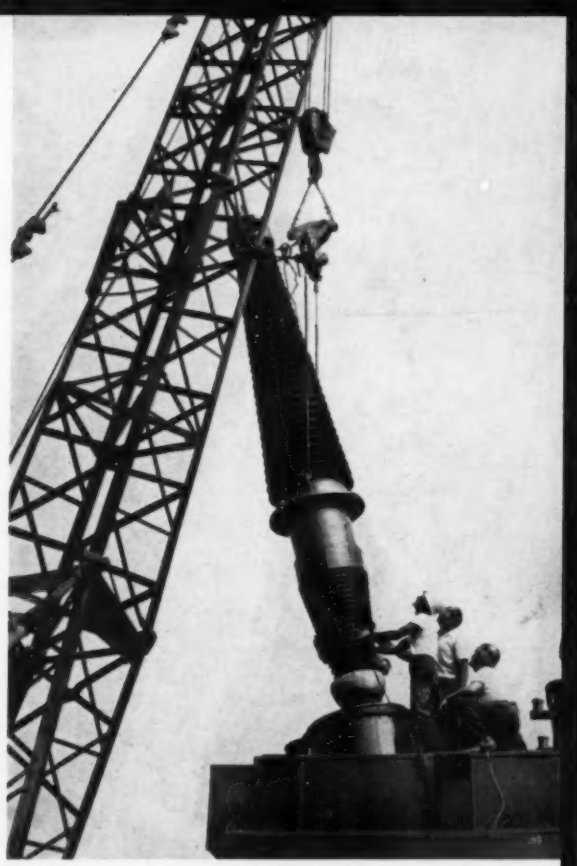
Fig. 2. Terrain's geographical, meteorological conditions in test area will make it possible to test for icing, snow, wind, lightning, etc, to develop construction for any location in system

Fig. 3 (below). This galvanized steel structure is 88 ft high, 100 ft wide, and is a part of the layout plan developed jointly by I-T-E and Penelec engineers

Fig. 4. These towers, made by Rilco Laminated Products, are first transmission structures ever to be made entirely of glued laminated wood. H-Frame, two-beamed, self-sustained design maintains the proper strength and performance for unusual load conditions







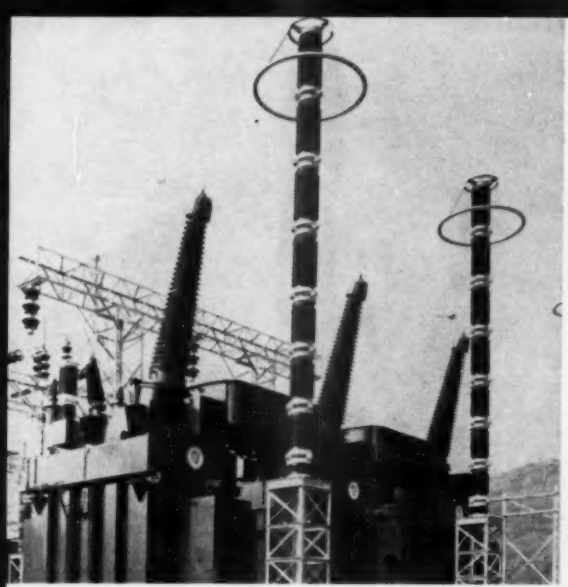


Fig. 5 (left). Ohio Brass Co supplied suspension insulators and other components, including transformer bushings. Bushings incorporate not only mechanical and electrical protection, but give new resistance to corrosion accelerated by higher operating voltages

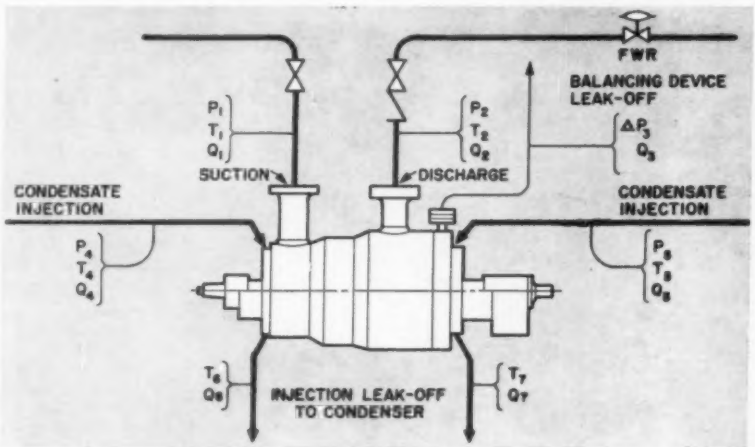
Fig. 6. Shown from the high-voltage side, these 460,000-volt transformers were supplied by Pennsylvania Transformer Div of McGraw-Edison Co. Photo was taken before any of the line connections had been made

BOILER FEED PUMP AUTOMATION

IGOR J. KARASSIK OF WORTHINGTON TELLS HOW TO INTEGRATE FEED PUMPS INTO OVER-ALL STEAM POWER PLANT AUTOMATION

COMPLETE automation of steam power plants is inevitable at some ultimate future date, though we do not know at this moment when this trend to automation will transform itself to an accomplished fact.

Automatic devices are already used either to position the feedwater regulating valve or alter the pump speed so as to balance the flow of feedwater with the steam flow from the boiler. Also automated is the recirculation by-pass used to protect the pump against overheating at light loads. No major changes are necessary in this area even if the plant operation is to be fully automated, except to integrate the operation of these devices into the over-all scheme. A great many other operational or supervisory functions, however, have not yet been automated except to a very limited degree.



Measurement of boiler feed pump characteristics for operation control functions

Objectives of Automation

Two specific objectives are applicable to boiler feed pumps:

1. To start, vary their operating conditions and stop, fully automatically in answer to plant demand and load conditions.
2. To permit the operation of these pumps without attendance.

We distinguish between two major classifications of controls: (1) Operation controls and (2) Supervisory controls. The first, shown in Table 1, are directed at such functions as starting or stopping a pump or altering its operating conditions.

The second category (Table 2) are intended to prevent the hazards of malfunctioning of the boiler feed pump or of its operation under conditions that could lead to malfunctioning.

Subdivisions of operational and supervisory controls are somewhat arbitrary in that some control functions are borderline cases and some others belong rightly in both categories.

Automation of a piece of equipment requires the measurement of a great number of variable or constant characteristics, evaluation of these measurements and the weighing of them against some predetermined norms, the correction of these characteristics where possible or necessary, and their continuous monitoring to assure that the necessary corrective measures have been carried out. In addition, automation requires that a rigid sequence of steps be observed during start-up or shutdown of the equipment and that feedback be incorporated to assure that before any one step of the sequence is taken, all previous required steps have been satisfactorily carried out.

This evaluation and correction and this sequential operation at start-up and shutdown must be accomplished by a computer or a computer component. But a computer has no imagination. It can only "think" of whatever a human being has thought of first. We must foresee all situations and instruct the computer how to deal with each one of them.

What are the variables in and about the boiler feed pump which can affect an automatic decision? Referring to the drawing, we must first measure the pressure (P_1), the temperature (T_1), and the flow quantity (Q_1) at the pump suction. We must also measure the corresponding quantities (P_2), (T_2), and (Q_2) at the pump discharge. If we do not wish to measure Q_1 and Q_2 at both the suction and discharge, either of these two flows can be measured and the other calculated by appropriately adding or subtracting any in- or out-flow. These measurements will, at all times, give us a complete picture of the pump hydraulic performance.

If the pump axial thrust is compensated by a balancing device, we will want to know the flow (Q_3)

TABLE 1

OPERATIONAL CONTROL FUNCTIONS

1. Start up pumps for initial start or for restart of the main unit.
2. Start up additional pump as station load increases.
3. Shut down one of the pumps on decrease of load.
4. Switch a spare pump for an operating pump.
5. Vary the position of the feedwater regulator or vary pump speed for station load change.

TABLE 2

SUPERVISORY CONTROL FUNCTIONS

A) Controls for Corrective Action:
1. Abnormally low flow—Excessive temperature rise.
2. Insufficient NPSH.
3. Insufficient condensate injection for sealing.
4. Insufficient oil pressure or flow.
5. Excessive oil temperature.

B) Controls for Pump Shutdown:
1. Excessive vibration.
2. Excessive shaft runout.
3. Excessive bearing temperature.
4. Failure of oil pressure.
5. Excessive axial thrust.
6. Excessive misalignment of pump and driver.

C Controls preventing Start-up:
1. Inadequate warm-up.
2. Insufficient oil pressure.
3. Lack of condensate injection for sealing.
4. Excessive misalignment.
5. Improper axial rotor positioning.

TABLE 3

SUPERVISORY CONTROLS (Corrective)

IMPULSE	CORRECTIVE ACTION
1. Abnormally low flows or excessive temperature rise	Open recirculation by-pass
2. Insufficient NPSH	A) For open feedwater cycles: a. Introduce auxiliary steam to the deaerator, or b. Introduce cold water to the pump suction, or c. Throttle condensate supply to deaerator, or d. Reduce feedwater flow to the boiler B) For closed feedwater cycles: a. Start up an additional condensate or condensate booster pump, or b. Switch suction supply to auxiliary storage tank.
3. Excessive condensate injection outflow temperature	A) Open injection control valve wide or B) Start auxiliary injection pump
4. Insufficient oil pressure or flow	Start auxiliary oil pump, or Switch to auxiliary oil filter
5. Excessive oil temperature	Open cooling water supply

taking place through this balancing device. Measurement of the differential pressure (ΔP_3) across the calibrated orifice in the balancing device leak-off line and comparison of this differential pressure with the orifice calibration curve will indicate this flow.

If the pump is provided with condensate injection sealing, the injection pressures, temperatures and flows at both ends of the pump must be measured. These are P_4 and P_5, T_4 and T_5, and Q_4 and Q_5 respectively. Temperatures (T_6 and T_7) and flows (Q_6 and Q_7) at the condensate injection leak-offs must also be measured. At each end, the difference between the injection and leak-off (Q_4–Q_6 and Q_5–Q_7) will indicate the amount of condensate that flows into the pump interior.

Pump speed (n_1) must be measured both for the purpose of correlating the pump performance to its initial performance and for instigating a number of supervisory control functions. If a variable speed device such as a hydraulic coupling is interposed between the pump and its driver, the input speed to the variable speed device (n_2) must also be measured.

Other Measurements

Several oil pressures and temperatures must be measured. These pressure measurements will be taken at the discharge from the pump shaft-driven oil pump, at the discharge of the auxiliary motor-driven oil pump and at the inlet to the pump bearings. Temperatures will be measured at the outlet of the oil cooler and at the outlets from the inboard line bearing and outboard line and thrust bearing. Bearing temperatures in the metal will be measured by thermocouples imbedded within the bearing shells and the thrust shoes.

For the purpose of determining proper temperature distribution during warm-up and for actuating sequential warm-up valve positioning, casing surface temperatures will be measured at several points. Optionally, we may wish to monitor the differential expansion of the pump casing by means of suitably located dial indicators.

Obviously, the actual measuring devices must be located right at the point of measurement. But sensing devices can transmit information to any desired location within the power plant. The question of where this information is to proceed is a very controversial one. In my opinion it is not necessary to transmit *all* of this information to the central focus of the power plant control room. Decisions on the operation of boiler feed pumps can be made either at the local level of the pump itself or at the top level of the control room depending upon the nature of the decision.

All information as to oil pressures, bearing temperatures, shaft eccentricity or vibration, casing surface temperatures, etc, should be fed into a local control center. The decision to shut down one of the pumps because of malfunctioning and to substitute a spare pump (if one is available) would be made there.

This decision would be transmitted to the main control room and the sequence of steps for shutting down the pump and securing it would be initiated at the boiler feed pump control center. This does not mean that a decision to shut the pump down could not be reached in the main control room as well. But the reasons for such a shutdown would be different from a local shutdown decision: the main control room would decide strictly on the basis of the load carried by the main unit or because the entire unit is coming down.

The integration of all controls into the complete computer entity is not necessary. Only operational information need be fed to this control computer, along with any decisions reached on the local level.

Operational Controls

To meet objectives (2) and (3) of Table 1, if more than one pump served the boiler, the automatic control must:

1. Sense the need for an increase or decrease in feedwater flow which can best be met by an increase or a decrease in the number of operating pumps.
2. Initiate an impulse which will meet this need.
3. Feed back the information on this action so as to check whether the need has been met.

Decisions to be reached by the operational control are the following:

1. If two pumps are operating and if the station load or total feedwater flow fall below that value which requires the operation of two pumps,

one of the two pumps is shut down.

2. If one pump is operating and if the station load or total feedwater flow are increasing and approaching that value which requires two-pump operation, an additional pump must be started up.

Both station load and total feedwater flow to the boiler are monitored at the "top" control level, that is at the main control room. Having sensed a condition requiring starting or stopping one of the boiler feed pumps, the control would send the corresponding impulse to the "local" control center, instructing it to act in accordance with the decision and proceed with the predetermined sequential operation.

Following is a typical sequence for starting a pump, not necessarily complete, but at least indicative of the fact that many individual actions are necessary.

1. Warm-up monitoring certifies that pump is ready to start.
2. Suction valve monitoring certifies that pump is ready to start.
3. Check valve monitoring certifies that pump is ready to start.
4. Cooling water supply to the oil cooler is opened.
5. Condensate injection valves are opened to the running position.
6. Recirculation by-pass opens.
7. Warm-up valving closes for running position.
8. Auxiliary oil pump is started up.
9. Oil pressure and oil flow measurements certify that pump is ready.
10. Motor is started up.
11. Motorized gate valve in discharge line opens.
12. Recirculation by-pass control switches to flow control.
13. Feedwater regulator or speed control device takes over and determines operating capacity of boiler feed pump.
14. Monitoring of operational and supervisory controls continues.

An initial start-up or restart initiates similar sequences of steps, except that certain steps (such as warm-up procedures) may be omitted.

Supervisory Controls

Table 3 lists the five items that appear under category "A" in Table 2 and indicates the impulse that would be used to initiate the corrective action and the corresponding action itself.

Several of these controls are already widely used in modern steam-electric generating stations. However, the effect of insufficient NPSH or of improper condensate injection sealing conditions is seldom monitored and even more seldom controlled. And yet, if proper protection is to be afforded the boiler feed pump, these two controls are essential even if the steam power plant is not fully automated.

The condensate injection system can be controlled directly by the temperature of the leak-off. A temperature-measuring device is located in the injection leak-off at each end of the pump, sending an impulse that adjusts the setting of individual valves in the two condensate injection supply lines. Because it is generally desired to reduce the amount of cold water injection whenever the pump is idle and on warm-up, a bias is incorporated in the control so that the injection leak-off temperature under idle conditions is permitted to exceed this temperature for running conditions.

Evaluation of Controls

It remains now to examine those supervisory controls that are intended to stop a pump or to prevent its start-up. Any abnormal condition should be reported at an annunciator panel. If the condition should be remedied but can be permitted to continue until further action is taken, nothing further is needed. But if the condition may endanger the equipment in question or related equipment, the piece of equipment must be shut down.

At first glance, this appears to be a very simple statement of requirement and easy to comply with. However, many conditions are potentially dangerous to satisfactory operation. The question is how many of these dangerous conditions can we afford to monitor and use to actuate shutdown sequence?

Protective as well as corrective controls are best evaluated if they are considered for what they really are: insurance premiums. The cost of providing these controls must be weighed against the probable expense which might be incurred should the hazards against which the controls protect the equipment be allowed to cause damage. While it may be exceedingly difficult to place a numerical value upon the probable damage, I would suggest that of the list of controls in categories (B) and (C) in Table 2, the following will generally be justified:

a. Adequacy of NPSH; b. adequacy of condensate injection supply; c. adequate supply of lube oil; d. monitoring for vibration; and e. monitoring warm-up operation.

The same vibration supervisory equipment that is normally used on steam turbine-generators can be applied to monitoring boiler feed pumps. It is only necessary to monitor the shaft vibration, and this measurement can be obtained with a so-called "seismic vibration detector." A probe with a spring-loaded bronze tip is used to produce an alternating voltage output that is proportional to the amplitude of the vibration.

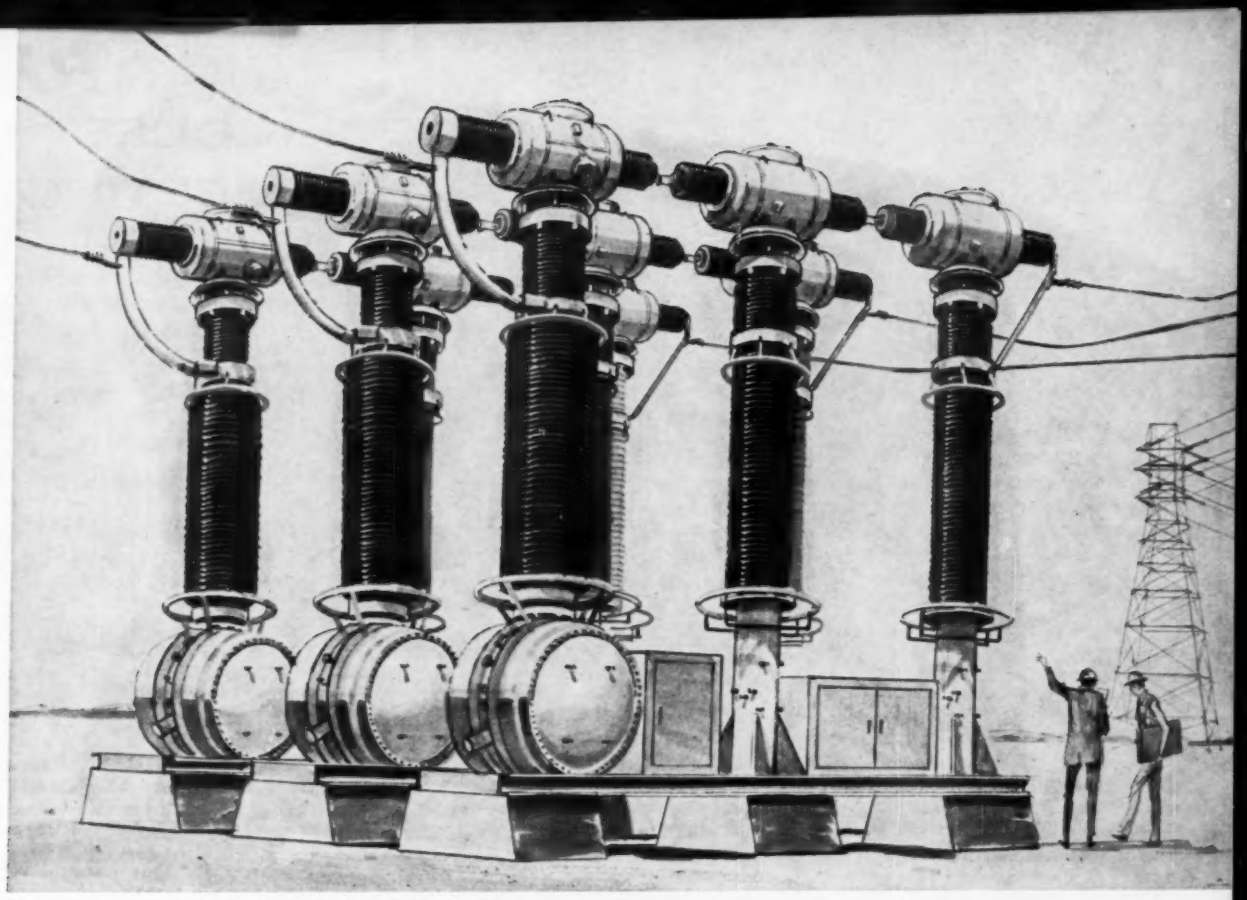
The supervisory information from the vibration detectors is transmitted to a power unit. By means of the sequential programming switch, each measured point can be read every 5 to 15 seconds. The indicator/alarm mechanism in the power unit can be set to give an alarm signal at one amplitude of vibration (for instance at 0.003 in.) and to shut down the pump at some greater amplitude (for instance 0.007 in.).

Shutdowns caused by such impulses as excessive vibration should include time delay relays with possibly as much as a 2 or 3 minute time interval. Vibration can easily be caused temporarily by a reduction in the available NPSH below the cavitation limit, and shutting down a pump under these circumstances is the most dangerous thing that can be done. The pump should be left running, and all efforts directed towards restoring adequate NPSH. These efforts should generally be successful within the suggested 3 minute time interval. If vibration were to continue after this, damage will have probably occurred, and the pump should be brought to rest to avoid further damage.

Alternately, an interlock with the NPSH supervisory controls can be used so that the excessive vibration impulse is prevented from shutting down the pump until after the inadequate NPSH condition has been remedied.

As to the warm-up protection, this requires the installation of an adequate number of thermocouples on the surface of the boiler feed pump casing. As soon as the pump is shut down and ready to be placed in standby position, the impulses from these thermocouples are employed to actuate the various valves used for maintaining the pump properly warmed-up. At the same time, the information from the thermocouples is interlocked with the starting controls so that start-up can be prevented if the temperatures of the pump casing differ at the various monitored points by more than a prescribed maximum value.

Integration of the boiler feed pump into an automated steam power plant presents no unsurmountable problems. It requires merely a thorough understanding of the various factors which can affect the operation of the pump and a logical analysis of the operating, corrective, and protective controls that will assure trouble-free operation. THE END



AIR-BLAST CIRCUIT-BREAKERS GET FASTER AND BIGGER IN AMERICAN ELECTRIC POWER SYSTEM

345-KV UNITS, BEING BUILT BY GENERAL ELECTRIC, WILL OPERATE IN TWO CYCLES

ORDERS FOR a series of the world's fastest operating air-blast power circuit-breakers has been placed by American Electric Power System, to help protect the 345-kv transmission network of the company's system. Five of these breakers have been ordered from General Electric Company, and installation is scheduled for 1962.

These breakers will be the first air-blast design to be built at this voltage, which will meet the AEP System's specifications of clearing short-circuit currents as high as 25-million kilovolt-amperes n two electrical cycles (1/30th of a second). The previous fastest, as guaranteed by the manufacturer, have been three cycles (1/20th of a second).

The air-blast design eliminates need for inflammable oils customarily used for high-voltage circuit interrupting means. Instead, the breaker uses air under compression as the interrupting medium. Temporary lightning-induced short-circuit arcs, and system disturbances, will be snuffed out automatically by blasts of self-replenishing high-pressure air stored within the breaker's interrupting chambers.

Inherent characteristics of the air-blast design make it possible to provide an exceptionally fast operating breaker, with low maintenance costs.

Citing the need for faster and more efficient power circuit-breakers, C. P. Zimmerman, head of AEP's Electrical Engineering Department, explained that the increasing number of higher-output generators going into service makes it imperative that transient power faults be cleared quickly to keep the power system in balance; hence, the requirement for the 2-cycle interrupting time. The faster fault-clearing will further the success of high-speed reclosing, to restore facilities to service in about ⅓ second.

The AEP System also has on order with General Electric a number of 138,000-volt air-blast breakers. They will be rated to interrupt 10-million kva, within two cycles. They are scheduled to be tested this spring with installation to follow later in the year. THE END

NEW CONCEPTS AND TECHNIQUES DISCLOSED AT AIEE WINTER MEETING

TO A REPORTER who has covered AIEE Winter Meetings for just about 40 years, the 1961 Winter General Meeting of the American Institute of Electrical Engineers held in New York, Jan 29 to Feb 3, bore little resemblance to the winter meetings held in the early years of the electrical industry, either in scope or substance. Those early meetings were concerned largely with 60-cycle power techniques, with papers and discussions concerning the theory, design, and operating characteristics of rotating machinery, overhead and underground transmission systems, and, to some extent, with telecommunication systems — only in those days they were not called telecommunication systems.

The term "electronics" had not come into use in the nineteen-twenties, but vacuum tubes were beginning to find extensive use in telephone systems. Radio, in those years, was the sole prerogative of the Institute of Radio Engineers. And, the meetings were small; there was no problem in holding them in the old Engineering Societies Building at 33 West 39th Street in New York.

This 1961 meeting was vastly different. While the "old-timers" might look back wistfully at the small, relaxed meetings where everybody knew each other and where most everyone spoke the same technical language, there was little doubt that this meeting, with its 120 technical sessions involving hundreds of papers and an attendance numbered in thousands, reflected the dynamic state and all-encompassing nature of the electrical art. With so many technical sessions, even the formerly ample facilities of the Statler-Hilton Hotel were no longer adequate, and the meeting overflowed into the Governor Clinton Hotel; some sessions were held at the old Engineering Societies Building on 39th Street.

Bats, Moths, Gambling

However, these physical changes represented by the number of technical sessions and papers constitute the least difference between earlier meetings and those of the present. The vast difference lies in the nature of the subjects discussed, in the involved dissertations on strange new concepts, and devices and systems completely unknown even two decades ago. For example, at the recent meeting there were papers on such things as tunnel diodes, ion-getter pumps, intercommunication between computer systems, Monte Carlo computer calculations of transmission line lightning performance, use of problem-oriented languages for programming for real-time control systems, reading electric heating papers in Russian and, believe it or not, a paper on the detection and evasion of bats and moths. This represents only a small sample of the strange and esoteric lingo that has come to characterize recent winter meetings.

At the Plasma Energy and High Voltage Insulation session, Dr. Mills of Princeton University discussed a realm of knowledge that was virtually unknown two decades ago — that involving the use of dense plasmas for power and processing. Here the speakers calmly discussed the attainment of temperatures tens and hundreds of millions of degrees. At this session Leonard Linde, manager of the C-Stellarator project at Princeton, in describing that fabulous thermonuclear experiment, briefly referred to the tremendous quantities of power that will be used in raising the rarefied gas in the Stellarator tube to these million degree temperatures.

To supply power to the system three 7000-hp induction motors, three 96-ton flywheels, and 12 d-c generators with a combined continuous rating of 48,000 kw at 600 volts are being provided. The maximum peak rating of this power system is 200,000 kw at 750 volts. The power leveling influence of the 20-ft diameter flywheels, however, will hold the peak power demands of the three 7000-hp motors to 48,100 kw. Included in the over-all project is a 4000-hp refrigeration system supplying air conditioning and chilled water for cooling the coils and equipment.

In the discussion of the application of high-density plasmas the point of interest inevitably shifted to MHD, that is, the possible development of a successful magnetohydrodynamic generator. Here again we find the electrical engineer dealing with a type of electrical conductor completely — or almost completely — unknown two decades ago. And yet, as was pointed out in the general discussion at this session, electrical engineers have worked with plasmas and controlled them magnetically in circuit breaker design. Although the temperature of the arc between the contacts of a power circuit breaker is relatively low (around 4000 C), there is enough ionization to constitute a weak plasma.

In discussing the cooling of the magnet coils of the C-Stellarator by the use of chilled water, the question arose as to whether cyrogenic cooling might not be used to produce superconducting magnetic coils. Although no plans are being made in this direction, the idea had been considered.

Lightning as Gambling Partner

The use of the Monte Carlo method in predicting transmission line lightning performance was of interest because the use of gambling techniques seem a long way from sound engineering design, yet such techniques are quite useful. Estimating the likelihood of winning in a gambling game and estimating the lightning performance of a new transmission line are in many ways similar processes. Both are concerned with making useful predictions from situations containing random processes; and in both, relationships involving probabilities dominate. The former is concerned with the probabilities of occurrence of certain favorable combinations of cards or other "indicating devices", whereas the latter is concerned with probabilities of unwanted combinations of lightning stroke and line characteristics.

Carry ng the analogy still further, one can, with no loss in precision, consider the prediction of transmission line lightning performance as a game that the designer plays against nature in which he estimates the "plays" that nature is likely to make with her lightning strokes, and creates a line design that should be proof against a given percentage of these plays. He then places his line into the game and history sums up the result as to whether he or nature won.

Just as history contains many instances of those who lost at cards because they could not properly estimate the probabilities involved, so it has become apparent that the industry is also in need of a better method of estimating the statistical relationship in calculating lightning performance. In his paper on this subject, J. G. Anderson of the General Electric Co examined these parallels more closely and described a computer routine that will handle large groups of probabilistic relationships in lightning flashover processes on transmission lines. THE END

BOWATERS UTILIZES BY-PRODUCT WASTE AS FUEL

At Bowaters Carolina Corporation, Detroit RotoGrate Stoker, with 6 Detroit air swept spout refuse distributor feeders, installed under Babcock and Wilcox 2 drum single pass steam generator. Steam is produced at 850 psig, 900° F-T.T. Feedwater temperature 300° F. Combustion air temperature is 350° F.

Bowaters Carolina Corporation's new plant at Catawba, South Carolina uses a Detroit RotoGrate Stoker to burn bark refuse under a steam boiler. The installation is designed to produce 200,000 pounds of steam per hour when burning bark alone.

Costly waste disposal measures, which in years past were common to pulp mill operation, have been eliminated.

Provision is made for future firing of coal either in conjunction with bark or separately, and 275,000 pounds of steam will be produced with this combination. Peaks of 300,000 pounds of steam are anticipated.

Oil and gas burners in the furnace walls are presently used for auxiliary firing if refuse fuel is not available in sufficient quantity to supply the demand for steam.

Versatile in their ability to burn a broad variety of fuels . . .

DETROIT ROTOGRATE STOKERS

. . . have an established reputation for efficient performance.

8417

DETROIT STOKERS COST LESS: Cost equals initial investment plus upkeep plus production losses due to equipment outage. *The total is less with Detroit.*

DETROIT STOKER COMPANY

DIVISION OF UNITED INDUSTRIAL CORPORATION

Main Office and Works, Monroe. Michigan • District Offices or Representatives in Principal Cities

For more data circle 527 on Post Card

NEW HIGH-VOLTAGE MOTOR CONTROLS INTRODUCED TO THE POWER FIELD

NEW 5000-volt motor controls, known as Space-Maker units, were announced recently by Allis-Chalmers Mfg Co. The new design is a radical departure from previous motor controls in this voltage range, in that it is only one-half the former size.

Unique design is possible because of a compact new air contactor, which permits the units to be stacked two-high. Thus only half the former floorspace is required. Each can have a full rating of up to 1750 hp maximum at 2300 volts or 3000 hp maximum at 4000–5000 volts. Each has interrupting capacity of 150 mva at 2300 volts or 250 mva at 4000–5000 volts by use of current limiting fuses.

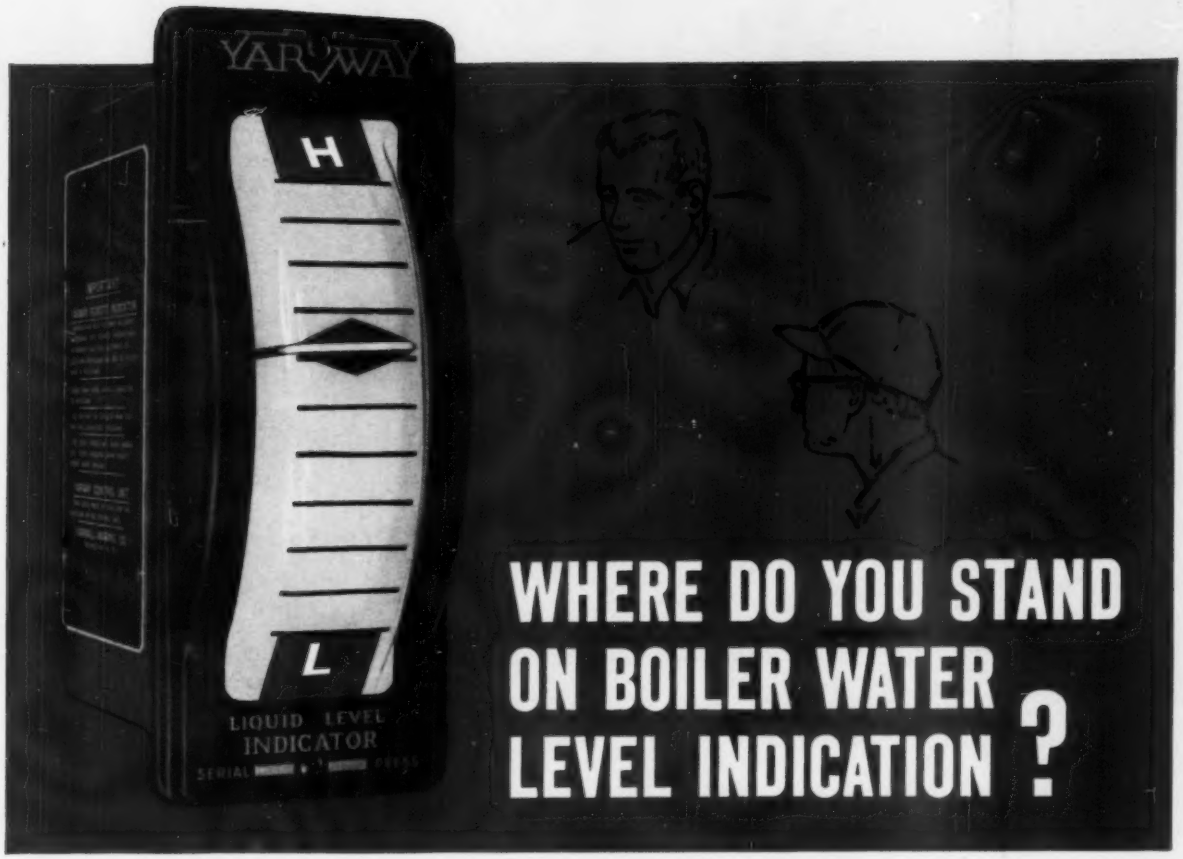
Heart of the new equipment is a 400-amp, 5-kv, 50-mva air contactor which uses a new glass polyester, flame-retardant, non-tracking insulation. Use of this material reduces contactor size to only 28 in. high by 16 in. wide by 24 in. deep. The two-high cabinet net size is held to 36 in. wide, 32 in. deep and 90 in. high.

New drawout feature consists of a wheeled contactor carriage that carries contactor, main fuses in their supports, main disconnecting fingers, control transformers and control transformer fuses, and a two-pole, double-throw test circuit switch.

A simple racking mechanism enables the operator to easily and safely move the contactor carriage from the operating position to the disconnected position and return. Also, a wheeled dolly is provided for use to receive the upper contactor carriage when it is drawn out for inspection.

Overload relays on the control are visible with the door closed. They are reset by buttons on the front door. For complete safety, the door cannot be opened until contactor carriage is in the racked-out position.

This new gear will be available as a complete line, with full-voltage and reduced-voltage, reversing and non-reversing controllers for cage, synchronous, and wound-rotor motors.



Yarway Remote Indicators have "wide angle" visibility from multiple vantage points

Yarway Remote Liquid Level Indicators bring distant, often hard-to-see boiler level readings right down to eye level on the panel board or other convenient location.

No matter where you stand—at any point in a 180° arc, and from a considerable distance—the brilliant new wide vision dial makes viewing and reading easy.

Accurate readings because Indicator is operated by boiler water itself

Remote readings of levels in boilers (also feed water heaters and other heat exchangers) are instant and accurate because indicator *operating mechanism* is actuated by the varying head of the liquid itself, yet the *pointer mechanism* is never under pressure.

Fully approved under Boiler Code Case #1155

Under A.S.M.E. Boiler Code Committee ruling in Case #1155, two independent remote level indicators of compensated manometric type may be used as primary indicating elements instead of one of the two gage glasses required for boiler pressures 900 psi and above. When both indicators are in operation, one gage glass may be shut off but shall be maintained in serviceable condition.

Yarway Remote Liquid Level Indicators conform to this ruling and are used widely for primary boiler water level indication in plants operating at 900 psi and above.

All Yarway Indicators for service over 700 psi are temperature-compensated; pressure compensation available when desired. Use of controlled-temperature column on constant head chamber fully protects against system upsets.

If you would like a reprint of this Boiler Code ruling, just ask for Case #1155 reprint.

Get the full story on Yarway Liquid Level Indication for your plant. Write for new 24-page Bulletin WG-1825.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

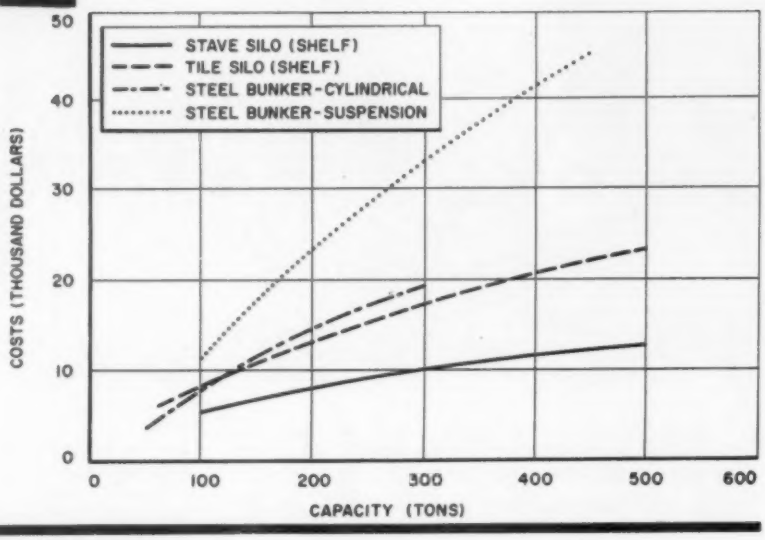
YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

For more data circle 528 on Post Card

Power Engineering HANDBOOK

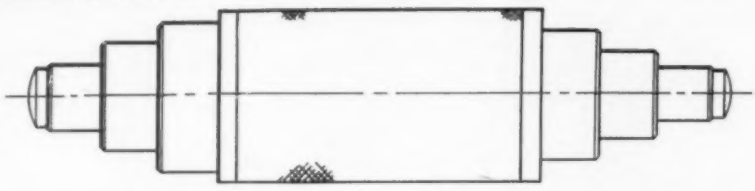
Costs Compared For Building Coal Storage Equipment

ENGINEERING DEPARTMENT of the National Coal Assn has prepared this chart which can be used as an estimating tool in determining the approximate cost of various types of in-plant and outside coal storage facilities, based on tonnage capacity. Data from which the chart was made came from a large number of actual proposals to furnish such equipment.



Here's a Handy Stepped Bushing Driver

By ROGER ISETTS



OFTEN on power equipment, brass or bronze bushings or other types of bearings need replacing. Pounding them in with a hammer can cause serious damage not only to the bushing but the housings as well.

Shown is a handy stepped drive that can be used for a variety for sizes. A round section of a good grade of steel is turned down on each end to take a number of standard diameters. The sizes and number of steps can be varied to suit individual needs. On each end a small portion is turned down and rounded slightly to provide a striking surface.

The driver may be hardened but should be drawn back so that it will not become brittle. Knurling the outside diameter will provide a good grip.

The driver may also be used on an arbor press if the housing is portable.

Compressed Air for Electricians

By GORDON LENAHAN

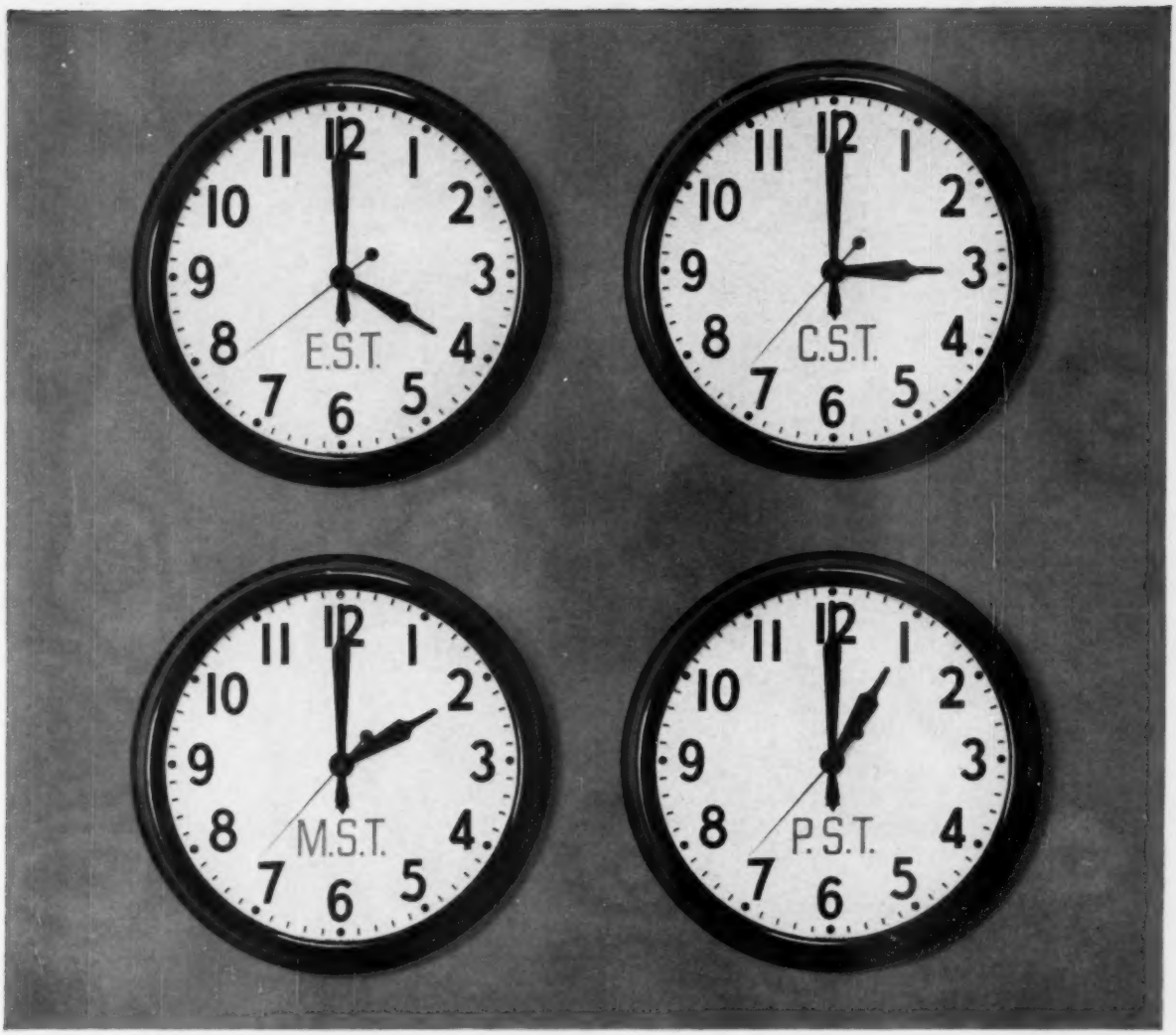
Natural Gas Pipeline Co

I WOULD LIKE to pass along three time-saving tricks that I have used to pull wire through electrical conduit, all using compressed air.

When it is necessary to add wires to a partially filled conduit, the fish tape often cannot be pushed through. A piece of string, preferably the fuzzy "store string," can usually be blown through easily. I hook a piece of copper tubing to the end of an air hose and feed it into the conduit with the string. After a few inches, the string proceeds on its own and will usually emerge from the first opening without difficulty.

I have also used this air-and-string method on installations where the conduit run was longer than an electrician's fish tape.

Same method can be used to verify the right conduit when the run is underground or concealed by building material. Merely remove two lids, direct an air stream into one, and if it comes out the other, it has to be the same conduit.



ONLY MORTON OFFERS A COAST-TO-COAST SALT SERVICE FOR EVERY WATER CONDITIONING NEED!

Wherever your plant is located, whatever salt you need and whenever you need it, Morton, America's only nation-wide salt company, can provide you with the kind of salt and service to keep your brinemaking equipment working at top efficiency!

MORTON PUREX is a quality controlled evaporated grade of salt that is 100% soluble. Purex dissolves rapidly and uniformly, producing a clear, fully saturated brine at highest possible flow rates.

MORTON '999' is a high-purity evaporated salt. It is particularly suitable for use in de-alkylizing units.

MORTON ROCK SALT is economical to use and comes from many sources in a wide range of particle sizes. Morton can supply the grade best suited to your needs.

Mail coupon today for more information about the various grades of salt and the valuable service Morton offers the Water Conditioning Industry.

Please send me additional information on

_____
(type of salt)

I would also like technical help concerning

_____
(type of water conditioning problem)

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

MORTON SALT COMPANY
INDUSTRIAL DIVISION
Dept. PE 3, 110 N. Wacker Drive, Chicago 6, Illinois

For more data circle 529 on Post Card

How We Blast Clean Large Turbine Parts

By **EDWARD SWITOW**, Engineer, Louisville Gas & Electric Co., Ky.

WHEN A TURBINE is completely disassembled for a scheduled overhaul and inspection, many large and small parts have to be thoroughly cleaned before reassembly. The large size and heavy weight of spindles, cylinders, stationary blading, bolts, and other parts can make this a time-consuming and laborious procedure. Very hard silica deposits on turbine blading can be removed only by scraping or more thoroughly by blast cleaning.

Blast cleaning presents the problem of how to contain the parts to be cleaned. The containing structure has to be large enough to enclose the largest part, usually the low-pressure cylinder, and must also be absolutely airtight to confine the cleaning dust. It is usually desirable to erect the enclosure as near as possible to the work area, to minimize transporting time of the heavy parts involved.

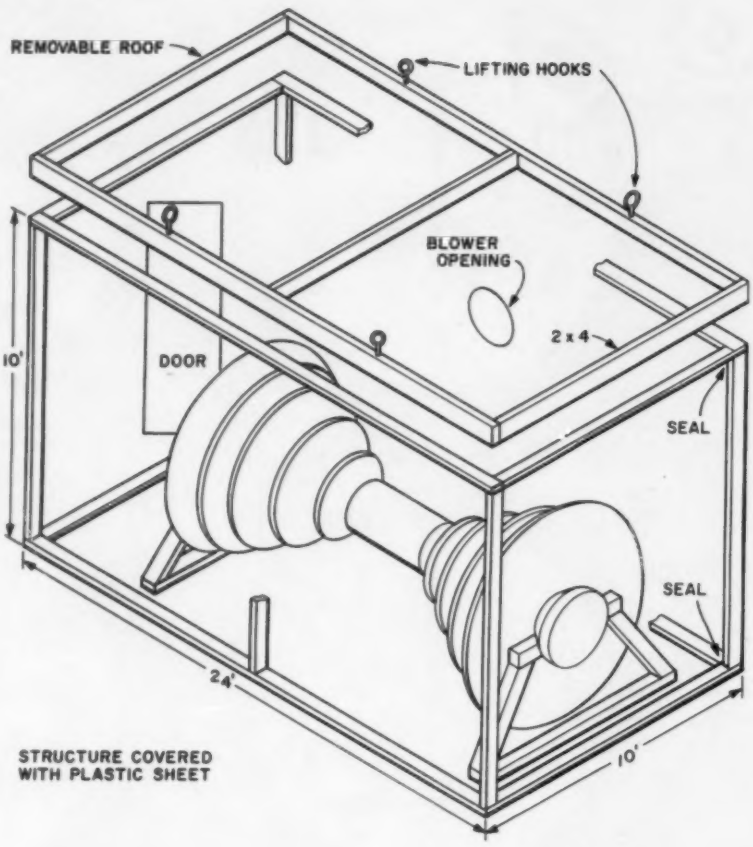
To satisfy both of these requirements we have constructed an enclosure using 2 by 4-in. lumber for the frame, and clear plastic sheeting for the covering material, instead of the plywood that was formerly used.

Clear plastic can be obtained in sheets 9 ft wide by 100 ft long, and is ideal for the outside covering of an enclosure such as this. It can be rapidly installed, is transparent enough practically to eliminate interior lighting, and can be made absolutely dust-tight.

To seal the entire structure foam rubber seal strips are put between the floor and sole plate of the frame structure. Strips of foam rubber are also nailed to the tops of the side walls, thus sealing the roof sections.

Since the cleaning process requires parts to be moved in and out of the enclosure, we made the roof section detachable. By having a removable roof, we can use a house crane to move the large turbine parts in and out. A small blower is installed in one side of the enclosure to maintain a negative pressure and carry the dust to an area outside the building.

Our cleaning equipment consists of an open top tank, air hose, nozzle holder, and cleaning nozzles. We use a house air supply system at 85 psig, a Mac-Clead holder and inexpensive Mac-Clead cast-iron $\frac{5}{16}$-in. nozzles. A 220-grit aluminum oxide powder does a very thorough cleaning job on spindles, stationary blading, and flange bolts.



How We Remedied Lack of Expansion Allowance in Piping

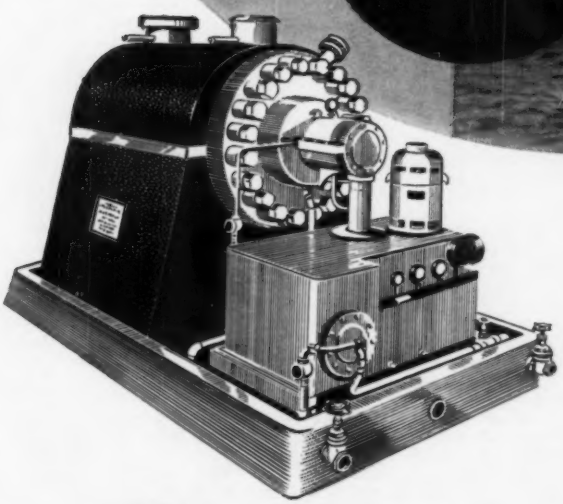
By **TOM MULLIN**

WE HAD SEVERAL long runs of ½-in. piping, in the plant yard, which required almost constant maintenance. Trouble seemed to be that expansion hadn't been allowed for. So we made a few cuts in the piping, taking about 10 in. in each cut. Then we installed two couplings and flare fittings (as shown in the sketch), and a bent length of ½-in. copper tubing (as an expansion bend). By this device maintenance was practically eliminated.

At the Albany Power Station

12

Pacific Boiler Feed Pumps Serve NIAGARA MOHAWK



Following the original installation of 6 Pacific Type BFI Boiler Feed Pumps in 1951 Niagara Mohawk added a battery of 3 Pacific Boiler Feed Pumps in 1952—and 3 more in 1953.

This record of repeat orders (one of many similar records) provides hard, factual evidence as to the dependability, efficiency and excellent design built into every Pacific high pressure high speed boiler feed pump. For additional data on these reliable pumps write for Bulletin 122.

PACIFIC®

BF-28

PACIFIC PUMPS INC.

A Division of Dresser Industries, Inc.

HUNTINGTON PARK, CALIFORNIA

For more data circle 530 on Post Card

CONSTRUCTION NEWS

Los Angeles, Calif. — The Board of Trustees of the Los Angeles General Hospital, Los Angeles County, 500 N. Temple St, has authorized $1,400,000 to be spent to install a central boiler plant at the hospital. Preliminary engineering work has begun, and installation is scheduled to be completed by the spring of 1962.

Crawfordsville, Ind. — City Department of Light & Power, City Hall, has authorized plans to extend and improve the municipal power plant, including for increased capacity the installation of a 12,650-kw turbine generator, boilers, and auxiliary equipment. Work will begin at once under supervision of Emery, Marker & Campbell, Toledo Trust Building, Toledo, O., consulting engineers. Cost, when completed sometime next year, is reported to be $3,150,000.

Baltimore, Md. — Baltimore Gas & Electric Co, Lexington Bldg, has announced plans for a major expansion and improvement program over the next five years of its generating and transmission capacity, which is reported to represent an investment to exceed $250,000,000. The utility expects to spend $45,000,000 of this amount in 1961 to keep pace with population growth of the area and to increase needs of present customers. New facilities required to handle the estimated growth over a five-year period are expected to increase company's investment in the plant by nearly 50 per cent.

Conowingo, Md. — Philadelphia Electric Co, 1000 Chestnut St, Philadelphia, Pa., has authorized plans to double the capacity of its hydroelectric power station located here with the installation of four turbines at Conowingo Dam on the Susquehanna River. Installation is part of a $450,000,000 capital improvement program scheduled to be comp'eted in 1966. Each turbine will have a generating capacity of about 65,000 kw, up from 36,000-kw capacity of each of seven turbines now in operation at the plant. Units are tentatively scheduled to go into operation by 1965 or early 1966. Project is subject to Federal Power Commission approval. Conowingo plant now supplies about 10 per cent of the energy requirements of Philadelphia Electric Co.

Jackson, Mich. — Consumers Power Co, this city, has authorized plans and will spend more than $98,000,000 in 1961 on expansion and improvement in its plants and equipment and for improving electric and natural gas services. During 1960, the Jackson, Mich.-based utility spent more than $106,000,000 on expansion of its generating equipment and distribution facilities, including completion of much of a natural gas pipeline program. Company expects to add 16,700 new electric customers to its lines in 1961. It has at present about 875,000 electric and 526,000 natural gas customers.

Minneapolis, Minn. — Northern States Power Co, 15 S. Fifth St, this city, a subsidiary of Northern States Power Co, Wilmington Del., has announced plans to spend approximately $48,800,000 for construction and improvements in its system in 1961, a slight decline from a $54,250,000 budget last year. Apart from a $7,500,000 expenditure in expansion of the company's natural gas service, most of the appropriation will go toward increased capacity of lines, installation of a new substation, and improved efficiency of transmission and distribution systems. Approximately $7,000,000 will go toward the construction of company's atomic plant now under construction at Sioux Falls, South Dakota, scheduled for completion late in 1962.

Lacey Township, N.J. — Jersey Central Power & Light Co, 601 Bangs Ave, Asbury Park, N.J., has authorized the purchase of an 800-acre plant site here for the construction of a giant power station. Property is bounded on the north by the south branch of the Forked River, on the south by Oyster Creek, on the east by Route 9, and on the west by the Garden State Parkway. Construction of the first phase of the station, a plant capable of 200,000-kw output in a period of about five years, would involve an expenditure based on today's construction costs of about $50,000,000. It will provide power to serve about 125,000 customers in company's growing southern division; additions to the plant will be made as the area's population increases.

Newark, N.J. — Public Service Electric & Gas Co, 80 Park Place, has authorized plans and will begin work soon on construction of a new steam-electric generating station on the Hackensack River, just north of the company's Marion Generating Station, at Jersey City, N.J. New station, to be known as the Hudson Generating Station, will at the outset consist of one turbine-generator with an initial capacity of 342,000 kw. The initial estimated cost of the new facility is reported to be about $84,500,000 and is scheduled for operation sometime in 1964.

New York, N.Y. — Consolidated Edison Co, of New York, Inc, 4 Irving Place, this city, has announced a record spending program of more than $305,000,000 in 1961 for expansion, mostly in new equipment, machinery, and buildings. This is the largest capital budget for any one year in the company's history and is upwards of $40,000,000 over the 1960 budget. For the five-year period 1961 through 1965, company's capital budget calls for expenditures of well over $1,100,000,000, inclusive of payments to New York City for the subway power plants acquired last year. Much of the expenditure will go toward expansion of Consolidated's electric system to supply the needs of 2,800,000 electric customers, and for future expansion.

Reno, Nev. — Sierra Pacific Power Co, 220 S. Virginia St, this city, has authorized plans to construct a new power plant, to be known as the Frank A. Tracy Steam Power Plant, on a large site acquired for the purpose in this city. Plans call for installation of a steam-electric generating unit with an initial capacity of 66,000 kw, high-pressure boilers, and auxiliary equipment. No estimate of project's cost is available at this time since it will not get under way until sometime in 1963 or 1964. Plans also include additional transmission lines, power substation, and other company improvements.

Cincinnati, O. — Cincinnati Gas & Electric Co, Fourth & Main sts, this city, has authorized an expenditure of about $47,000,000 for expansion of its generating and transmission facilities through 1961. Program for this year revolves around the construction of a fifth unit with a capacity of 250,000 kw at company's Walter C. Beckjord station near New Richmond, Ohio. This unit is scheduled for completion in the fall of 1962, when it will increase the Ohio utility's total generating capability to 1,500,000 kw. Plans call for installation of new power transmission and distribution lines to distribute the power potential of the new installation.

Piqua, O. — Municipal Power & Light Dept, City Hall, this city, has approved plans and will proceed with work at once on major expansion of municipal steam-electric power plant. Work will include increased generating capacity for increased output along with addition to transmission lines and facilities. City has awarded a contract of $718,631 to Charles H. Shook, Inc, Dayton, O., for the work which will be completed in the spring of 1962.

Portland, Ore. — Agreement of a proposed merger of California Oregon Power Co, Medford, Ore., into Pacific Power & Light Co has been approved by the directors of both companies with a proposal to exchange 1.2 shares of Pacific Power common stock for each share of California-Oregon common. Provisions for exchange of preferred stocks and other merger details are being worked out by a joint committee of directors. Both companies estimate that more than $500,000,000 in construction will be required over the next ten years, which will nearly double present utility plant investment. Magnitude of the capital requirement was an important reason for the merger.

Youngsville, Pa. — Warren Electric Coöperative, Inc, has requested the Federal Power Commission to grant a permit to study the power potential of the Kinzua Dam project, under construction by the Corps of Engineers on the Allegheny River upstream from Pittsburgh, Pa. Company has plans under consideration for the construction of a run-of-river plant at Kinzua Dam with a capacity of 17,500 kw; a possible re-regulating dam and a second powerhouse 2.5-miles downstream from the dam that could raise output to somewhere between 30,000 and 75,000 kw; and a pump-generating plant with a capacity of between 50,000 and 125,000 kw. Pennsylvania Electric Co would operate all power facilities and supply power to the 13 members of Pennsylvania Rural Electric Assoc.

Blackwell, Texas — West Texas Utilities Co, 1062 North Third St, Abilene, Texas, has authorized plans and will start construction at once on a new steam-electric power plant here. Contract in the amount of more than $1,000,000 has been let to the Austin Co, 16112 Euclid Ave, Cleveland, O., for the work, which is scheduled to be completed in the fall of 1962. An additional contract of $452,000 has been let to cover cost of installing power plant piping to the National Valve & Manufacturing Co, of Pittsburgh, Pa.

Crockett, Texas — Houston County Electric Coöperative, this city, has authorized plans and will begin work on installation of pole transmission lines, extensions, transformers, and the like in its system. Cost of the installation should be approximately $132,000 when completed in the fall of this year.

Tacoma, Wash. — Department of Public Utilities, Light Division of the City of Tacoma, Wash., has announced that slides and floods jolted two penstock elbows and flooded the powerhouse cofferdam at the site of its Mayfield hydroelectric generating plant on the Cowlitz River. Mayfield Dam, upstream from the plant, was unaffected, but work on the powerhouse has been set back more than two months with damage estimated at more than $100,000. Plant is now 60 per cent completed and will include Mayfield Dam, 185 feet high and 45 feet wide, an 860-ft tunnel 37 ft in diameter, and a generating plant with a capacity of 160,000 kw when completed in 1963.

TVA NEWS

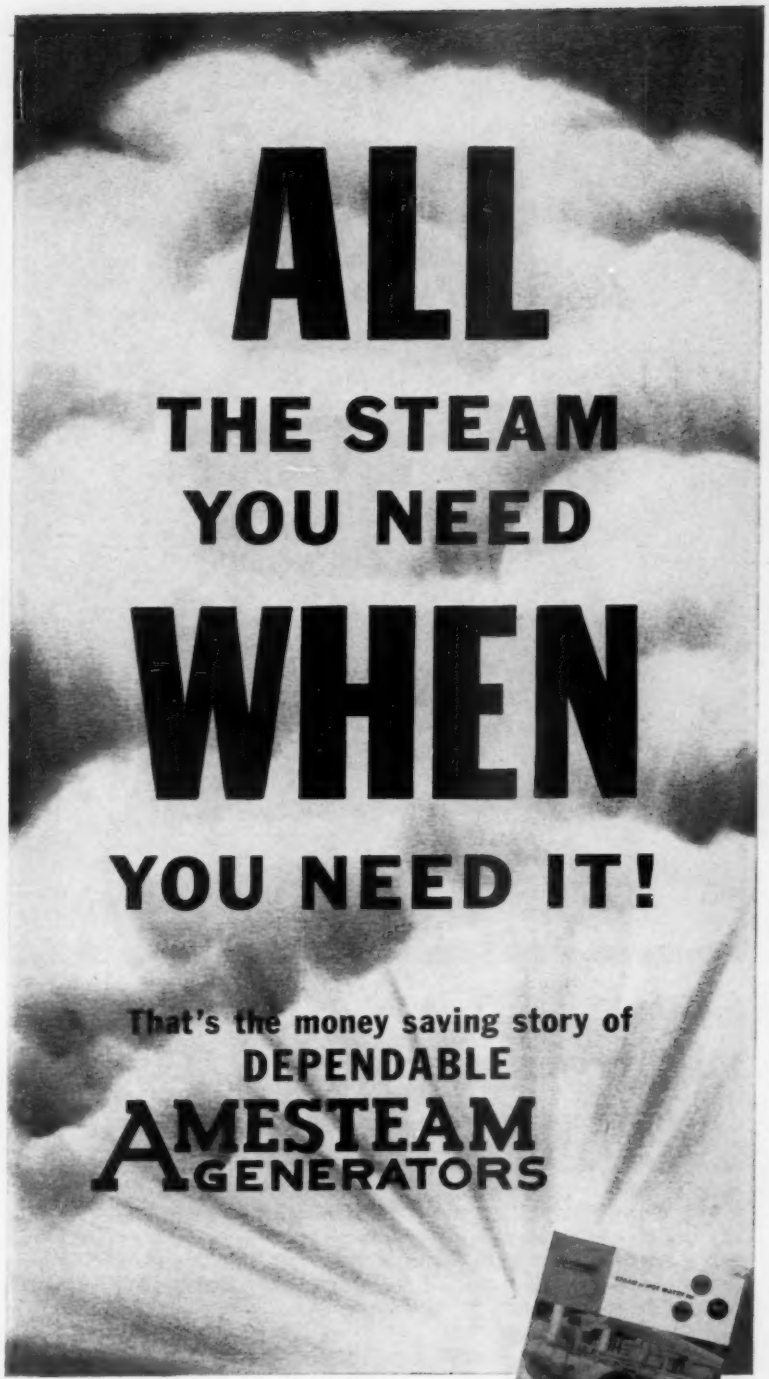
NET INCOME from TVA's power operations during calendar year 1960 exceeded $52 million. This exceeded by $2.6 million the 1959 total, according to the agency's report for the second quarter of its fiscal year 1961. Net power proceeds ("cash flow") totaled nearly $102 million for the year.

New records of loads and generation were established during the quarter. A peak hourly demand of 10,322,000 kilowatts in January exceeded December's peak by 20,000 kw and last winter's peak by 681,000 kw. Sales to municipal and coöperative distributors were 9 per cent higher than in the corresponding quarter a year ago.

In December, TVA placed an order with the General Electric Co for two 800-Mw turbine generators, which will be the largest ever manufactured. (See POWER ENGINEERING, Feb 1961, p. 46.)

Construction progressed on three million kilowatts of other new generating capacity, most of it in five record-size steam generating units to be in service by the end of 1963. When the first of the 800-Mw units is in service, the installed capacity of the TVA power system will exceed 15 million kilowatts.

TVA paid a dividend of $20.7 million to the United States Treasury on the appropriations invested in the power system. This is half the total payable during fiscal year 1961.



Write today for this helpful bulletin
"Steam or Hot Water for Power, Heat, Process"

AMES IRON WORKS, INC.

BOX U-31 OSWEGO, NEW YORK

For more data circle 531 on Post Card

Specify BLAW-KNOX Electroforged® Steel Grating

A primary function of open flooring is to admit light and air to areas above and below its surface . . . to provide safer, more comfortable working conditions. Blaw-Knox Electroforged Steel Grating is designed to provide maximum open area.

Load requirements establish equal bearing bar dimensions for all types of grating, in equal service. Because it is Electroforged, Blaw-Knox grating can get maximum strength from crossbars only ¼ inch square. This means less obstruction to light and air, and safer, more comfortable working conditions above and below.

Visibility is only one way Electroforged grating increases safety. Sure footing is provided by the non-slip, twisted crossbar and a choice of either square, or serrated bearing bars. Electroforged grating is self cleaning, too. There are no joints or crevices to collect dirt and grease.

Electroforged grating also is available in other materials such as Monel, Cor-ten and aluminum. Write for Bulletin 2581 for further information. Blaw-Knox Company, Pittsburgh 38, Pa.

Blaw-Knox Equipment Division

BLAW-KNOX
GRATING

For more data circle 532 on Post Card

New Engineering Books

The technological revolution of this century gains in momentum year after year as new concepts and research continue to lay groundwork for more variegated fields of endeavor and development.

Much of what we now know and produce would not have been possible had it not been for our fundamental understanding and early exploration in the field of electricity and electronics.

Electricity and Electronics — Basic, Second Edition (by William B. Steinberg and Walter B. Ford; 262 pages, 6 by 9¼ in.; published by American Technical Society, 848 E. 58th St, Chicago 37, Ill.; price $4.50) will do much to encourage young students to consider seriously the wonderful opportunities in this dynamic field. Laymen will add to their basic knowledge about electricity and electronics — facts which they never before troubled to look up for fear of becoming entangled in highly technical jargon.

This sample list of subjects outlines the scope of this work: Making Use of Magnetism, How Electricity Is Produced, Basic Electrical Circuits, Electricity for Everyday Living, Using Electricity for Communication, Basic Electrical Formulas, Standard Symbols for Electronics, and many practical projects.

The first edition of **Electricity and Electronics — Basic** ran through four printings and won wide acceptance in the industrial arts and by educators in vocational training schools, technical institutes, and adult training courses.

This updated version strives to make the instructional method of the first edition even more effective. New material is included on transistor fundamentals and silicon rectifiers.

★ ★ ★

Energy in the American Economy, 1850–1975, by Sam H. Schurr and Bruce C. Netschert, et. al.; 774 pages, 6½ by 10 in., cloth bound. Published by The Johns Hopkins Press, Homewood, Baltimore 18, Md. Price $12.50.

This comprehensive study of energy's role in the United States economy was done by the Resources for the Future organization. Concerned with the future as well as with the past, the book is divided into three parts: 1. A Century of Energy Use, 1850–1955; 2. and 3., The Future of Energy Consumption and Supply. One hundred and twenty tables and 73 figures complement the text. A valuable section of over 250 pages comprises the appendices.

As for energy consumption and availability by 1975, the book makes this over-all conclusion: Viewed strictly from the stand point of its natural resource position and

with due allowance for technological advance, the United States in 1975 or thereabouts could satisfy its demands for all energy, and for each of the energy materials of which the total is composed, from domestic sources of supply at no significant increases in costs, except for those which might be brought about by a rise in the general price level.

This analysis predicts an 88 per cent increase in total energy consumption between 1955 and 1975. In billion kwh the total for 1975 is estimated at 1966, compared with 633 in 1955.

Extremely valuable as a base from which to consider the nature of energy use for tomorrow is Part I of this study. This is a thorough and scholarly interpretation of the statistical record of energy supply and demand over a span of 105 years. Much is made of the historical relationship between energy consumption and gross national product, in an effort better to understand the complex relationship between energy use and economic growth, and to find hypotheses for analysis which appear to fit the facts.

In this work, Resources for the Future has provided a monumental source book of figures and facts organized and interpreted to give meaning and significance to the total picture of energy at work in and for the American economy.

★ ★ ★

Alternating-Current Circuits, Fourth Edition, by R. M. Kerchner and G. F. Corcoran; 602 pages, 6 by 9¼ in. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N.Y.

Revisions in this 4th edition bring up to date a long popular textbook. Following the trend toward the scientific approach, new material has been added on topology, duality, and the pole-zero method of circuit analysis. Also, the term *phasor* has been adopted for a time-varying quantity which is handled by vector methods.

An introductory chapter on network concepts has been added to provide deeper insight into general methods of network analysis.

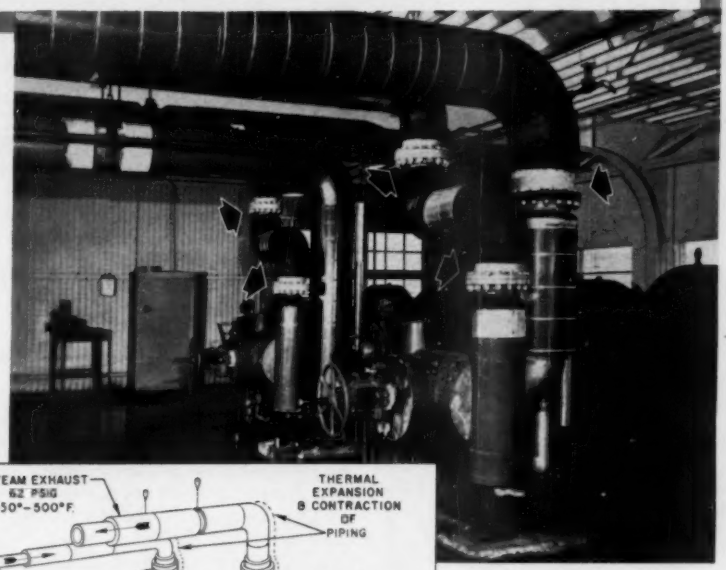
Chapter V on single-phase circuit analysis has been expanded to consider complex frequency and poles and zeros. These concepts are again introduced in Chapter XIV in connection with transient analysis of the RLC circuit.

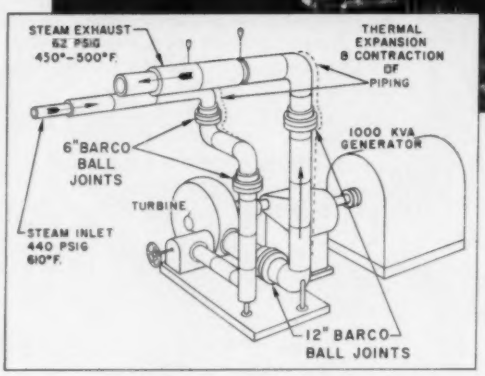
To hold the book to approximately the same size, even though a considerable amount of new material has been added, subject matter from Chapters X and XI of the 3rd edition has been largely eliminated. These chapters were titled *Alternating-Current Measurements* and *Determination of Circuit Parameters.*

★ ★ ★

Engineering and Technical Conventions, prepared by Deutsch & Shea, Inc; 42 pages, 8½ by 11 in.; paper cover. Published by Industrial Relations News, 230 West 41st St, N.Y. 36, N.Y. Price $4.00, including fall

Barco Handles Expansion on Steam Turbine Piping—





BARCO

BALL JOINTS

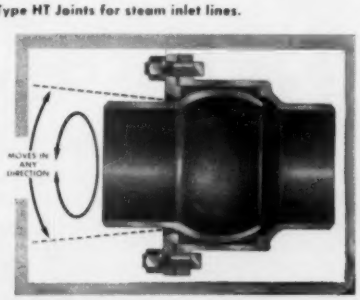
1. Handle Expansion **2. Relieve Torsion** **3. No "End Thrust"**

PROBLEM For the turbine installation shown above, layout of the piping presented involved pipe stress calculations to allow for thermal expansion and to eliminate torsional effects. In addition, a considerable expenditure had to be allocated to cover construction of heavy pipe anchoring and to control expansion "end thrust". *Could engineers find a better way to solve these problems? THEY DID!... and they saved about $2,000.00.*

ANSWER Instructions were simple: (A) "Install Barco Ball Joints —two* in each riser near turbine." (B) "Cut loose anchor stops; allow piping to move freely in all directions." (C) "Use spring hanger supports for the long horizontal runs of piping."

*Standard Type N for exhaust; High Temperature Type HT Joints for steam inlet lines.

Barco Ball Joints provide convenient points of flexibility in piping to allow for both expansion and twisting. They develop NO "END THRUST"; expensive anchoring is not required. Easy to engineer. Rugged all-steel construction with no thin wall sections, no critical points of fatigue, no rubber seals. No lubrication required. Sizes and styles to meet your requirements. *Ask for new Bulletin 31B, "Thermal Expansion and Contraction in Piping."*



BARCO MANUFACTURING CO.

547D Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

For more data circle 533 on Post Card

supplement. Discounts on quantity orders.

This year's edition provides data on almost 700 state, regional and national meetings on technical subjects ranging from acoustics to high-polymer physics to welding. Over 170 technical societies, universities, and other groups contributed information on their 1961–1965 meetings.

Engineering and Technical Conventions provides administrators, marketing people and technical recruiters, as well as individual engineers and scientists, with advance information on where and when technical meetings will be held. The publication is indexed by technical subjects of the meetings, sponsoring organizations, and locations. An appendix lists participating organizations.

Annual issue is published in January. A supplement, published each fall, provides additional information on new meetings scheduled since the annual issue went to press.

★ ★ ★

The Control of Multivariable Systems, by Mihajlo D. Mesarovic; 112 pages, 6 by 9¼ in. Published jointly by The Technology Press of The Massachusetts Institute of Technology and John Wiley & Sons, Inc, 440 Park Avenue South, New York 16, N.Y.

While lauding the growth of control theory during the past two decades, the author maintains that considerable improvement would result if theory were based on multivariable systems rather than on single-variable models.

In the author's opinion a theory of multivariable control should have its foundations in properties specific to multivariable systems. The first part of the book is devoted to the most important property of this nature: interaction. The black box problem is discussed, and the significance of indeterminacy in interrelations is emphasized, especially by contrast to indeterminacy in single-variable systems.

In the second part, a representation of systems by binary operations is developed.

The aim of this book is to provide a foundation for the development of a control system dealing specifically with multivariable systems. To this end new concepts are introduced. The final goal is conceptual, and interest in developing skills for dealing with special problems is secondary.

★ ★ ★

Fuel Cells, by D. R. Adams, P. Cathou, R. E. Gaynor, R. D. Jackson, Jr., J. H. Kirsch, L. L. Leonard, G. S. Lockwood, Jr., W. P. Warnock, and R. E. Wilcox, Jr.; 160 pages, 11 by 8½ in., paper cover. Published by Fuel Cell Research Associates, P. O. Box 157, Cambridge 38, Mass. Price $18.75.

Originally written as partial fulfillment of the requirements for the degree of M.B.A at the Harvard Business School, this study is directed not only to a technical audience, but also to the general business world.

Considerable technical material is covered to provide background information, but a major objective was to determine commercial and engineering practicality of present and potential fuel cells.

A method is established for evaluating fuel cell performance, for analyzing existing fuel cell developments, and comparing present and future fuel cells with conventional sources of power in various applications. A technical and economical discussion of d-c motors is included to complete the fuel cell study.

★ ★ ★

Distribution Systems, by Electric Utility Engineers of the Westinghouse Electric Corp, East Pittsburgh, Pa.; 567 pages; 8½ by 11¼ in. Price $8.00. Copies may be obtained from Westinghouse Electric Corp, Merchandise Mart, Chicago, Illinois.

This volume is intended principally to serve as a reference for electric utility distribution engineers. However, it should be an extremely valuable source of information for any power systems engineer concerned with electrical distribution. It may also be useful as a college text.

Westinghouse plans a three-volume Electric Utility Engineering Reference Book to provide a complete reference to all the fields encountered in the utility industry:

Volume 1. System Analysis and Generation

Volume 2. Transmission and System Protection

Volume 3. Distribution Systems

It was felt that the most urgent need was for a practical reference on distribution systems; so Volume 3 is published first. Extent of coverage is indicated by the chapter titles:

1. General Considerations of Distribution
2. Load Characteristics
3. Subtransmission and Distribution Substations
4. Primary and Secondary Distribution
5. Secondary Network Systems
6. Distribution Transformers
7. System Voltage Regulation
8. Application of Capacitors
9. Voltage Fluctuations on Power Systems
10. Protective Device Coördination
11. Metering Principles and Practices
12. Street Lighting

Appendix: Tables of conductor impedance and physical characteristics; trigonometric functions; residential underground distribution design practices; and application data for lightning arresters.

Index

★ ★ ★

Metallic Corrosion Inhibitors, by I. N. Putilova, S. A. Balezin, and V. P. Barannik; translated from the Russian by G. Ryback; edited by E. Bishop; 196 pages, 5½ by 8¾ in. Published by Pergamon Press, Inc, 122 E. 55th St, New York 22, N. Y.

Theoretical and practical aspects of the application of corrosion inhibitors are reviewed in this monograph. Inhibitors are classified according to their characteristics when added singly or as mixtures to corrosive media; examples of synergism and antagonism are given, and the effects of tempera-

ANOTHER NEW ACHIEVEMENT IN MODERN FLOW CONTROL BY CRANE

1 Single retaining nut holds cartridge assembly in body, for fast, foolproof dismantling and assembly

2 Teflon* thrust washer reduces stem friction; absorbs line pressure load on ball

3 Teflon* seats pre-loaded for tight shut-off with minimum torque

4 Bright plastic grip insulates handle and flags valve position

5 Positive, Standard Size O-ring seals on stem, cartridge

6 Self-aligning, precision-machined ball, polished and chrome-plated to minimize friction and wear on seats.

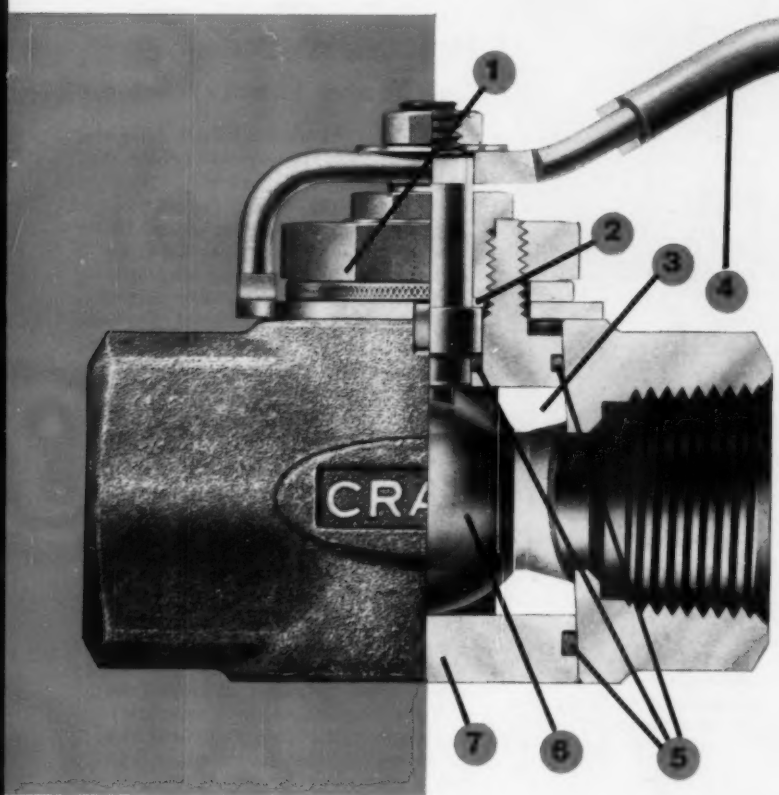
7 Tapered cartridge contains all working parts; slips out bottom in one piece for cleaning or maintenance

* Teflon is a registered trademark of E.I. DuPont de Nemours & Co., Inc.

CRANE BALL VALVES

with the exclusive tapered cartridge that drops out for fast, in-line servicing

designed to handle all air and water services to 400 F



There's a beautiful simplicity in these newest ball valves—Crane-designed for sure, safe, versatile service. The heart of the valve is a tapered cartridge—remove one retaining nut and the cartridge slips out the bottom for cleaning or maintenance, and then slips back, exactly in place, while the valve body remains in the line. The Teflon* seats are precisely pre-loaded for bottle-tight closing with a quick, easy quarter-turn of the handle—even with air or gas, vacuum to 800 psi, temperatures from —40 to 400 F. The handle is insulated, for hot service, and its bright Crane orange quickly flags the valve position—in-line for open, stand-out for closed.

Crane Ball Valves give you smooth flow; shut off tightly in either direction. All steel parts are plated for corrosion resistance.

Available now for prompt delivery at competitive prices—sizes from ¼" to 2", screwed ends, in bronze, steel and Type 316 stainless.

Call your Crane Distributor or send today for a complete, illustrated folder on the outstanding new Crane Ball Valves, engineered for unmatched service.

CRANE

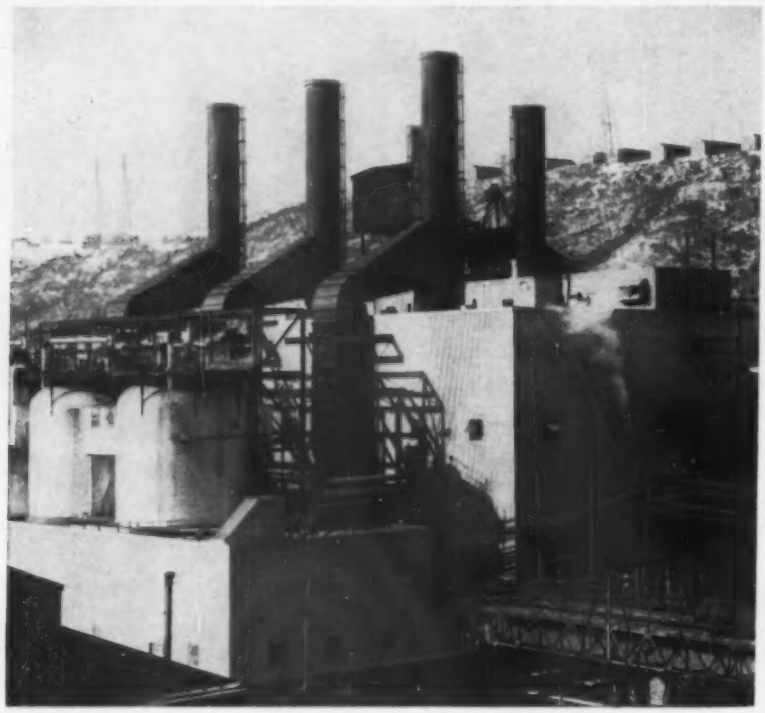
CRANE CO. Industrial Products Group
4100 South Kedzie Ave., Chicago 32, Ill.

In Canada, Crane Ltd., 1170 Beaver Hall Square, Montreal

Valves/Electronic Controls/Piping/Plumbing/Heating/Air Conditioning

For more data circle 534 on Post Card

HOW HAGAFILM® ELIMINATED $10,000 A YEAR POWER PLANT CORROSION COSTS



Quick case history—reading time 52 seconds

THE PLANT: Large power station serves U.S. Steel's National Tube Division at McKeesport, Pa. Monongahela River water is used for boiler make up.

River water is clarified with Hagan Coagulant Aid and alum, softened with lime and soda ash and deaerated for use in boilers. Desuperheating condensate system was forecast as corrosion weak spot because of high CO_2 in steam. To evaluate cost of maintenance versus treatment, National Tube engineers adopted a "wait and see" policy.

THE PROBLEM: Magnitude of corrosion was almost unbelievable. Standard 1" x 2" x 20 gauge carbon steel test strips pitted through within 24 hours. Low pressure heater shells had to be continually patched. Spill-over lines and fittings failed almost weekly. Maintenance costs rocketed to a high of $10,000 a year.

THE SOLUTION: Treatment with Hagafilm reduced corrosion rate from a no treatment level of 1285 to less than 1 mg/dm²/day with a 4 ppm feed; and to a range of 5 to 10 mg/dm²/day with a 2 ppm feed. Present feeding is 3 ppm.

RESULTS: Since introduction of Hagafilm four years ago, no failures have occurred in spill-over system lines and fittings. Corrosion in entire system has been arrested.

National Tube engineers say that Hagafilm treatment has already paid for itself many times over in reduced labor and maintenance costs.

FOR FULL INFORMATION on Hagafilm, write for free Bulletin 410-12-7.

HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON CO.–HALL LABORATORIES–BRUNER CORP.

For more data circle 535 on Post Card

ture and movement of the medium are also described.

ix chapters are devoted to a discussion, illustrated by numerous graphs and tables, of corrosion inhibitors suitable for aqueous acids, aqueous alkalis, neutral aqueous solutions and non-aqueous media. The important volatile inhibitors against atmospheric corrosion are included.

An appendix gives practical directions for using inhibitors during the removal of rust and boiler scale, among other things.

Numerous references are made to the literature (many of them to Russian work), and an index is provided.

How Can We Double Our Water Supply?

IN THE FISCAL YEAR 1961, reports U. S. Commissioner of Reclamation Floyd E. Dominy, this country expects to devote around $600,000 on engineering research, and the Bureau of Reclamation is asking the Congress to appropriate $250,000 in non-reimbursable funds to apply against this amount. Considering the widespread use of our research findings, $250,000 seems a modest amount, Dominy comments.

Why is more research urgent? Because water development is in a squeeze, Dominy says. Construction costs rise while water supplies available for development fall. Reservoir sites become fewer while the need for them becomes greater. Future projects will be far more complex and costly than those undertaken in the past. Yet, per capita use of water goes up, and the amount of good land devoted to agriculture goes down as urban areas develop. All contribute to a squeeze that makes it imperative that we follow the most efficient processes for the development and use of water supplies.

The Challenge

As Dominy puts it, this is our challenge:

Of the national average precipitation of 30 inches, only three inches — 10 per cent — are diverted or withdrawn for man's use. How might this be doubled?

The United States' population will be around 230 million by 1975. To feed and clothe this number, our agricultural productivity must increase nearly one-third faster than it has during recent years or our standard of living will drop. One of the surest ways of stabilizing and increasing agricultural production is by irrigation. Can we do it?

Water wasting is a luxury we must forsake, Dominy urges. We have

barely crossed the threshold of knowledge about control of water-wasting weeds — about the amount of water a food plant needs to mature — about how to apply water to crops efficiently.

We are improving our knowledge about efficient conveyance of water, but information is scant about drainage and groundwater. Evaporation knowledge and control is a new field in which we are making some progress, particularly in the use of hexadecanol on reservoir surfaces (see POWER ENGINEERING, June 1960, page 76).

Research Needs

Dominy outlines these dominating needs in research today:

1. Research ways to conserve and increase usable water supplies. Cut losses by evaporation and useless evapotranspiration. Improve techniques for delivering water to crops, and for growing the crops. Invent efficient methods of shielding bodies of water from the effects of the sun and air. Improve control of runoff and learn more about how to increase water yields from forests and snowbanks. Develop weather control and more reliable weather forecasting.

2. Research ways to enhance engineering efficiency. Such ways are numberless, but here are a few of them. Design hydraulic structures and develop materials to reduce erosion. Invent protective coatings or techniques that will assure a life of say 100 years for steel pipes and conduits. Develop chemical sealants to make canals watertight at low cost, and chemicals more effective in killing weeds and other phreatophytes, such as salt cedars. Devise better methods of working and placing concrete, and of making it resistant to erosion, cavitation, cracking and chemicals. Explore the new and large field of epoxy resins, which has astounding potentials. Learn how better to compact soils.

Valve Manual Reprints

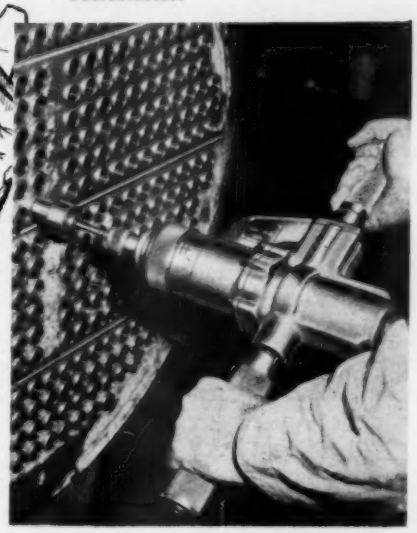
Recently out of print, the Power Engineers'Valve Manual is again available. It covers the basic types of valves. Although there are hundreds of different styles, all are modifications of the types covered in the Manual.

To obtain a free copy write the Editor, POWER ENGINEERING, 308 E. James St, Barrington, Ill. Quantity lot prices will be quoted on request.

AIRETOOL stands up under torture

Yes sir! You can depend on Airetool for speed, accuracy and economy in tube maintenance

Airetool pneumatic tools—cleaners, drills, brushes and motors—are designed to meet the specific needs of refiners for efficient, low-cost tube maintenance and to do the job under the most difficult conditions.



For example, the AIRETROL Tube Expansion Control, illustrated at right, rolls up to 12 tubes a minute within .001 inch accuracy; maintenance costs drop and expensive tube failures are reduced. Labor costs are cut, too, because Airetrol's rugged, lightweight construction makes one-man operation easy.

And, one man can remove the hardest deposits and clean completely plugged tubes with Airetool's CC-475 Condenser Cleaner. The built-in flushing system keeps the drill cool and the cuttings washed away.

If you're plagued by high tube maintenance costs, investigate the economies of Airetool tube equipment; it puts you on stream sooner and keeps you there longer. For full information write to:

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

More than 30 years' experience in pneumatic tools

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
Representatives in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.
CANADIAN PLANT: Brantford, Ontario.
EUROPEAN PLANT: Vlaardingen, The Netherlands.

For more data circle 536 on Post Card

ROOF TOP

BOILER ROOM in the Brooklyn Union Gas Company Building leaves basement clear for parking 32 cars... and two

SUPERIOR PACKAGED BOILERS do the job...

The first of two 600 hp. Superior Packaged Boilers is shown being hoisted to the top of the new 14-story Brooklyn Union Gas Co. Building in Brooklyn, New York.

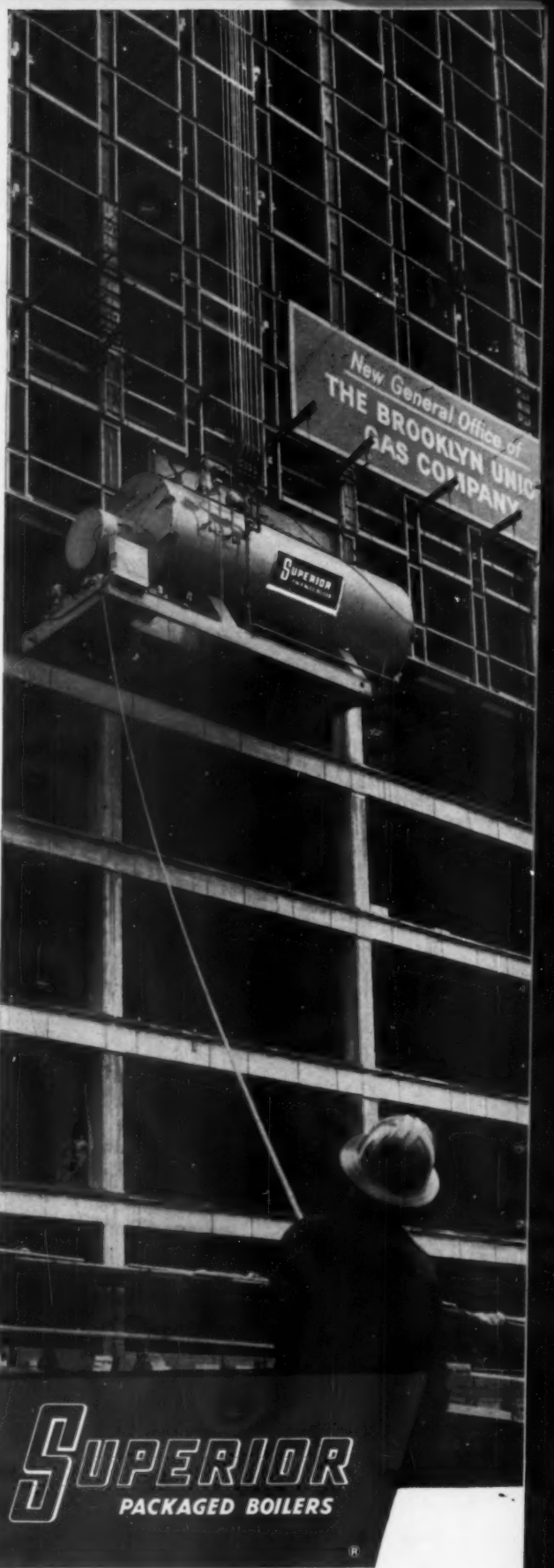
These two high pressure Superior Packaged Boilers . . . probably the largest ever installed so high above the ground . . . will supply both heat and hot water for the entire 14-story structure as well as heat for a second 4-story bank building to be erected adjacent to the new sky-scraper.

The roof-top installation was planned by the consulting engineers* to make more efficient use of valuable basement space which will be used for parking 32 company cars, a car-washing rack, storage, and offices for dispatchers, drivers, and building maintenance personnel. The roof-top installation also saves both the expense and the space for a chimney extending from ground to roof-top.

Each of the Superior Packaged Boilers is equipped for fully automatic operation burning gas at high thermal efficiencies. Superior's continuous gas pilot provides maximum safety of operation.

*FRANCISCO & JACOBUS
Engineers and Architects

Superior Packaged Boilers of the fire tube type are available in 17 sizes from 20 to 600 bph. Water-tube types in sizes to 60,000 lbs./hr. The catalog illustrated provides condensed data on the world's most complete line of packaged boilers. Request catalog S-12.



Fire-Tube and Water-Tube PACKAGED BOILERS

for STEAM or HOT WATER

SUPERIOR COMBUSTION INDUSTRIES INC.

TIMES TOWER, TIMES SQUARE, NEW YORK 36, N. Y.

SUPERIOR PACKAGED BOILERS ®

For more data circle 537 on Post Card

Current Catalogs

continued from page 32

distribution centers, busway and service entrance equipment. Includes application data and dimensions.

151 Floor Boxes — Featured in Catalog Form 705, released by National Electric Div., H. K. Porter Co., Inc., are standard floor boxes designed to accommodate a wide range of receptacles. Dimensional data tables included.

152 Aluminum Fittings — Sixteen-pp Bulletin AL 60 introduces Appleton Electric Co.'s line of aluminum Unilets, stressing corrosion resistance, light weight ease of handling. Provides design data, sizes and prices on Unilets, junction boxes, accessories, switch covers, receptacles and vaportight lighting fixtures, accessories.

153 Portable Cords and Cables — Applications and advantages of company's portable cords and cables are detailed by Kaiser Aluminum & Chemical Corp. in 52-pp Form KW-915. Describes insulation compounds, performance insulation, and jacket compounds, as well as portable cords and cables, includes splicing data.

Construction

154 Concrete Additive — Described in 6-pp Bulletin X-5a are Master Builders Co.'s products for improving concrete and other masonry products, including Pozzlith, a water-reducing admixture for concrete. Includes performance data.

155 Why Pre-Mixed Mortar — Use of Embeco pre-mixed mortar as a method of achieving tough, non-shrink water-resistant joints and masonry repairs is detailed by The Master Builders Co. in Bulletin EPMM-2B. Illustrated instructions for use plus comparative compressive strength test results are provided.

Other Equipment

156 Packaged Demineralizers — Described by The Permutit Co. in this 6-pp bulletin are standard packaged demineralizers — mixed-bed, two-step and non-generable types. Advantages of the package systems are discussed and properties of lon exchangers are summarized.

When using the Reader Service Cards, please be sure to give your company name and job title, even if you want catalogs sent to your home. Manufacturers prefer to send literature to those who identify themselves.

157 Automated Boilers? — Pros and cons of automated boiler operation are set forth in 12-pp Bulletin G-101 of The Babcock and Wilcox Co. Originally an ASME-AIEE Power Conference paper, this informative study treats current status and future of boiler automation. Covers computer programming, methods of automation, flame detection and burner control, weak links, significant design innovations. Lists major benefits of automation and disadvantages to be weighed against them.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

POSTAGE WILL BE PAID BY —

POWER ENGINEERING
308 East James St.
BARRINGTON, ILLINOIS

FIRST CLASS
PERMIT No. 11
Sec. 34.9 P. L. & R.
BARRINGTON, ILL.

POWER ENGINEERING
MARCH, 1961

Please have manufacturers send me, without cost or obligation information or literature indicated by the numbers circled below.

Name.....Title.....

Company Name.....
(Must be included)

Company Address.....City.....State.....

(If you prefer delivery at home, give home address, too)

Home Address.....City.....State.....

Equipment							
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53			

Current Catalogs											
101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124
125	126	127	128	129	130	131	132	133	134	135	136
137	138	139	140	141	142	143	144	145	146	147	148
149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172
173	174	175	176	177	178	179	180				

Advertised Products and Services											
501	502	503	504	505	506	507	508	509	510	511	512
513	514	515	516	517	518	519	520	521	522	523	524
525	526	527	528	529	530	531	532	533	534	535	536
537	538	539	540	541	542	543	544	545	546	547	548
549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572
573	574	575	576	577	578	579	580	581	582	583	584
585	586	587	588	589	590	591	592	593	594	595	596
597	598	599	600	601							

Use this space for tear sheets or other information wanted.....

.....

.....

(This card VOID AFTER JUNE 30, 1961)

POWER ENGINEERING
MARCH, 1961

Please have manufacturers send me, without cost or obligation information or literature indicated by the numbers circled below.

Name.....Title.....

Company Name.....
(Must be included)

Company Address.....City.....State.....

(If you prefer delivery at home, give home address, too)

Home Address.....City.....State.....

Equipment	1	2	3	4	5	Current Catalogs	101	102	103	104	105	106	107	108				
6	7	8	9	10	11	12	13	109	110	111	112	113	114	115	116	117	118	119	120
14	15	16	17	18	19	20	21	121	122	123	124	125	126	127	128	129	130	131	132
22	23	24	25	26	27	28	29	133	134	135	136	137	138	139	140	141	142	143	144
30	31	32	33	34	35	36	37	145	146	147	148	149	150	151	152	153	154	155	156
38	39	40	41	42	43	44	45	157	158	159	160	161	162	163	164	165	166	167	168
46	47	48	49	50	51	52	53	169	170	171	172	173	174	175	176	177	178	179	180

Advertised Products and Services	501	502	503	504	505	506	507	508	509	510	511							
512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	
530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	
548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	
566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	
584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	

Use this space for tear sheets or other information wanted.....

.....

.....

(This card VOID AFTER JUNE 30, 1961)

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

POSTAGE WILL BE PAID BY—

POWER ENGINEERING

308 East James St.

BARRINGTON, ILLINOIS

FIRST CLASS
PERMIT No. 11
Sec. 34.9 P. L. & R.
BARRINGTON, ILL.

158 Heat Exchangers — Twelve-pp Bulletin 302.1K1 describes two standard heat exchanger lines of American-Standard Industrial Div. Discusses applications and engineering features of the exchangers, which have straight tubes, externally packed floating tube sheets, removable bundles, single- or two-pass design. Gives design and dimensional data for units in 6- through 31-in. and 6- through 17-in. sizes.

159 Pipe Tools, Machines — This catalog, about 32 pp, presents the complete line of pipe and tubing tools and machines of Toledo Pipe Threading Machine Co. Sections of the catalog are devoted to tubing tools and machines; pipe wrenches, cutters, threaders, bolt dies and vises; power drives and power pipe machines. Fully illustrated, book provides construction and application data, and includes price lists.

160 Rust Prevention — Tested procedures for preventing and removing rust under almost any conditions are detailed by Oakite Products, Inc., in Service Bulletin 16B. Covers safe removal of rust from raw stock; prevention of hydrogen embrittlement during rust removal; simultaneous removal of rust and grease; prevention of rust during storage; washing with simultaneous rust protection etc.

161 Panel Type Filters — Characteristics and applications of panel type air filters made of Dynel are described by Union Carbide Development Co. in Bulletin A1. Performance graphs, and diagram of typical arrangements included.

162 Improved Cylinders — Advanced design and construction features of air and hydraulic cylinders of Mo-Bar Hydraulics Co. are described in three new bulletins. Provided are enlarged cross-section views with detailed specifications, mounting styles and accessories. Bulletin 202 presents air cylinders, pressures to 200 psi; Bulletin 203 covers medium pressure (500 to 2000 psi) hydraulic cylinders; and Bulletin 204, high pressure (2000 to 3000 psi) hydraulic cylinders.

163 Fire Fighting Equipment — Interior fire fighting equipment made by The Fyr-Fyter Co. is illustrated and described in 16-pp Form S-62FPB. Includes engineering and specification data on fire extinguishers, fire hose and extinguisher wall cabinets, hose racks, hose reels, angle valves, fire hose, nozzles, and accessory equipment.

164 Graph Sheets — Illustrated and described by Keuffel & Esser Co. in this 88-pp booklet are graph sheets, cross section and profile papers, cloths and films. Includes guide to selection and use.

165 Conversion Guide — Controlled electrical power is explained in this 16-pp static power conversion guide by Hamilton Standard Div., United Aircraft Corp. It outlines advantages of static power equipment and provides useful comparisons between static power devices and rotating electrical devices.

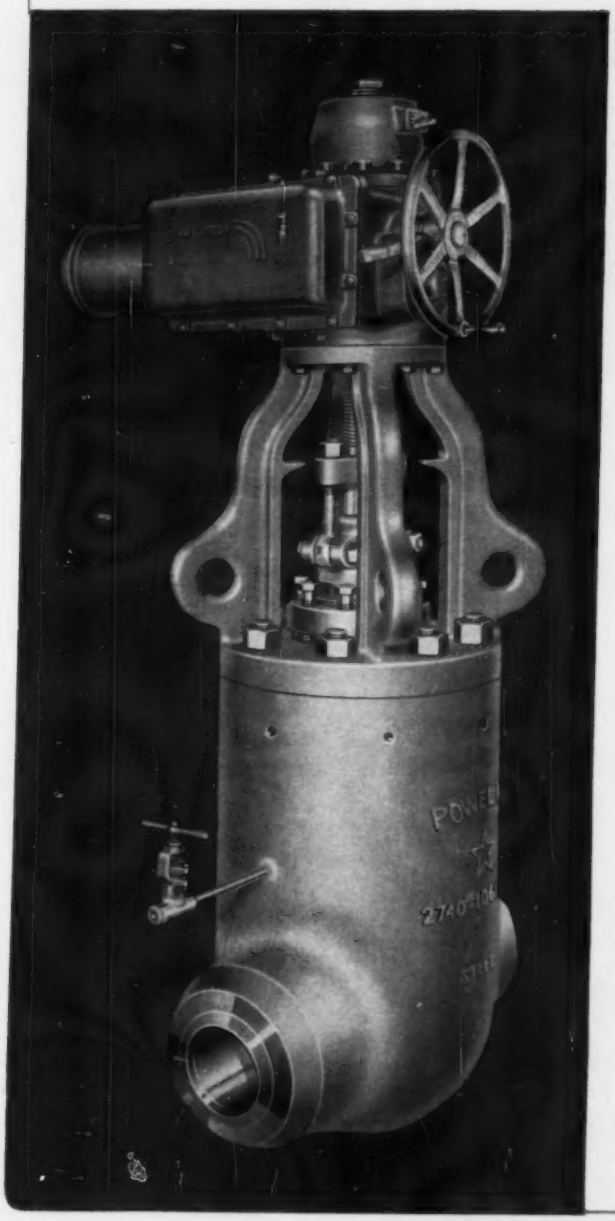
166 Miniature Filter Assembly — Engineering Bulletin 600 of Dumont Engineering Corp. provides information on a miniature in-line filter assembly applicable wherever caustic and/or corrosive liquids or gases are handled. Descriptions, photos, drawings and specification data are given. Applications include: filtration for instrument and gaging points; fuel systems; petroleum, chemical and food processing.

EXTRA POWELL VALVE NEWS

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

115th year of manufacturing industrial valves for the free world

NEW HIGH PRESSURE—HIGH TEMPERATURE VALVE FOR POWER PLANT OPERATION



AT 2740 psig AND 1060° F

Powell proudly presents this new Pressure Seal O.S. & Y. Gate Valve, especially engineered for ultra high pressure-high temperature service in one of the nation's largest modern plants. Its outstanding performance results from many key design features, such as:

- Body, Bonnet and Wedge of Chromium-Molybdeum Steel, according to ASTM specification A-217, Grade WC9.
- Internal working parts constructed of long-wearing materials, proven for uninterrupted service under severe operating conditions. Stellite facings on the wedge and seat rings.
- A Chrome-moly Bleed-off Valve extends through the body and facilitates valve opening by relieving pressure within the valve when it is closed.
- The top mounted weatherproof Electric Motor Operator, for remote control, has a *Spring* that automatically compensates for the changes of contraction or expansion of the valve stem, wedge and body. Proper and precise seating at all times is assured.

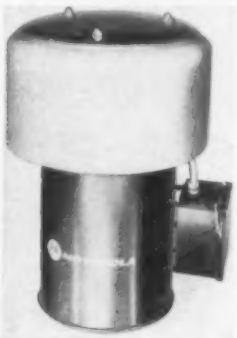
Development of this new high pressure-high temperature gate valve is positive evidence of Powell's ability to meet any industrial valve requirement—with regular or special designs—in bronze, iron, steel or alloys—for water, oil, gas, steam, and corrosive service. For further information or assistance, consult your nearby Powell Valve Distributor, or write direct.

For more data circle 539 on Post Card

Equipment News

1—Remote alarm indicator mounts at base of utility pole

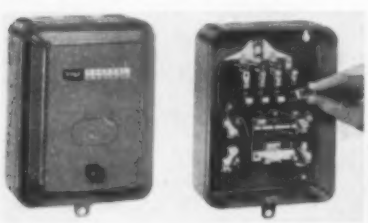
This unit consists of a 25-w radio transmitter and tone coding device, mounted in a steel-hooded, pressurized transformer tank. The transmitter, connected by cable to an antenna on top of the pole, sends out a tone signal when actuated. In most installations, the unit



operates in conjunction with the recloser and is triggered if a line fault causes the recloser to lock out. The alarm signal is radioed to a base station and a digital recorder in a centrally located office, notifying utility personnel of occurrence and location of line failure. Manufacturer Motorola Inc., points out that recent FCC rule changes permit use of this type of device to indicate abnormal conditions as well as actual failures. Power utilities may tie indicator systems to their regular two-way mobile networks and use same base station.

2—Size 00 motor starter offers easy contact inspection

Only one moving part and easy contact inspection are features claimed for Federal Pacific Electric Co.'s NEMA Size 00 motor starter. It is designed for low load applications such as compressors, pumps, blowers and conveyors. The 2-hp starter operates with a ball-bearing guided moving assembly consisting of movable magnet and contacts. Operation is straight-line and vertical, eliminating possibility of accidental closing. To facilitate maintenance, NEMA 00 starter has many parts in common with NEMA 0 starter. Simple removal of spring clip in relay changes it from manual to automatic reset. It comes in Nema 1 (general purpose) enclosure or without enclosure for panel use.



Reader Service Cards on pages 93–94 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

3—Speed reducers designed for higher horsepowers

According to Cleveland Worm & Gear Div., Eaton Mfg. Co., these worm gear speed reducers offer horsepower capacities up to 80 per cent higher than conventional reducers of the same type. This is attributed mainly to fan cooling, with plastic or aluminum, radial type fans claimed equally effective in either direction of rotation. Line is available in nine sizes between 3-in and 12-in. center distances, ratios from 4-½:1 to 95:1, and ratings ranging from fractional up to 175 hp.

4—Air monitor detects radiation in air-borne iodine vapors

For protection of personnel working near reactors, the AM-2S is designed by Nuclear Measurements Corp. to detect, measure and record the amount of specific gamma activity within energy range of 0.33 to 0.55 MEV and to warn of any alarm condition. In addition, the unit can be set for other gamma emitters for any energy range. Vapors are deposited on an activated carbon filter. Iodine activity is detected and recorded, and when a present alarm level is reached, a built-in bell and light both signal the warning. By employing optional count ratemeters and detectors the AM-2S offers many program possibilities. It is mounted on a mobile cart.

5—Big-space truck offers maneuverability, easy load access

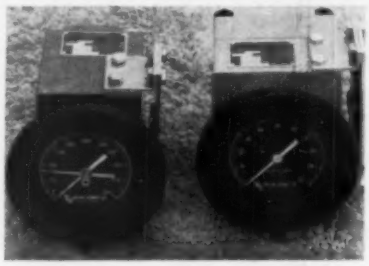
Higher capacity (862 cu ft), increased load accessibility and greater operating maneuverability are claimed for Boyertown Auto Body Works' 18-ft Merchantvan. With loadspace measuring 216 in. long, 88½ in. wide and 78 in. high, this truck is designed to handle big, bulky cargo-hauling jobs. Three sizes and types of rear and side door combinations provide loadspace access of the type and size required.

6—Tap changer designed to maintain service continuity

This manual underload tap changer, according to Line Material Industries, is suited to transformer installations where it is necessary to accommodate seasonally fluctuating, or steadily increasing loads. It can be furnished as an optional feature on tapped distribution transformers rated 10 to 167 kva, 2.4 to 14.4 kv. The external actuating dial has raised letters which indicate position of the tap changer. Holes along the outer edge of the dial permit hook-stick operation. Windings are protected by using resistors which limit the short-circuit current through the portion of the primary winding that is bridged during each tap change.

7—Instruments for high differential pressure service

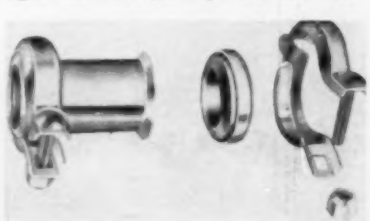
Now in production by Industrial Instrument Corp. are two units for application where high differential measurement is required. Model 1000 has a working pressure rating of 1000 psi and is available in differential pressure ranges to



1000 psi. Model 5000 has a working pressure of 6000 psi, comes in differential pressure ranges to 5000 psi. Both are available as recorders, indicators, transmitters, controllers, indicating switches, and as basic units for combination with other devices. Bulletin 90-H-1 gives full information.

8—Pipe joint in improved design and wide size range

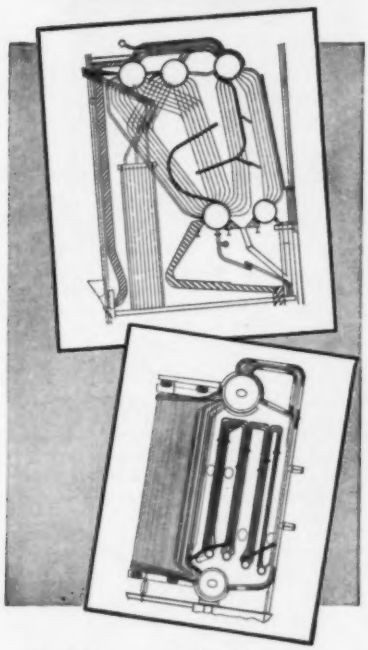
Flexmaster Pipe Coupling is now available in an improved design and wider range of standard sizes from ⅜ to 4 in. and lengths from 2 through 36 in., according to Marman Div., Aeroquip Corp. Gasket is contained in gasket retainer for uniform pressure of gasket against pipe and sleeve, and coupling ends have been redesigned to increase band tension load. Elbows, crosses and tees are also available. According to company, Flexmaster joins plain pipe ends quickly and easily without cutting or threading, absorbs pipe vibration and shock, allows up to 4-deg angular misalignment and permits both angular and axial pipe movement without leakage. Manufacturer says the new Flex-



ONLY ENCO BAFFLES

give you all these

COST CUTTING FEATURES



These important fuel-saving maintenance-reducing features are obtainable with Enco boiler baffles—*and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottlenecks**
- **Reduced draft losses**
- **Higher heat transfer**
- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.

THE ENGINEER CO.

75 WEST STREET, NEW YORK 6, N.Y.

In Canada: Rock Utilities Ltd., 80 Jean Talon St. W., Montreal, P. Q. sc-808

For more data circle 540 on Post Card

BIRD-ARCHER'S 8 POINT WATER TREATMENT PROGRAM

Designed for Inplant Testing... Performed by Your Personnel... Backed by Experts

If you use water for power, process or cooling, it will pay you to look into Bird-Archer's 8 point Water Treatment Service. Every step in this Service is performed by qualified chemists and engineers whose main task is to design a system that can be implemented by *your own personnel* and at the same time place at your disposal *60 years' experience* in solving water treatment problems.

Bird-Archer's 8 Complete Engineering Services

- Complete studies of your use of water or steam.
- Exhaustive analysis of water supplies starting at source.
- Modern laboratory with seasoned chemists specializing in water analysis and research.
- Operational changes where necessary.
- Custom formulated chemical treatments for your specific needs.
- Complete analysis of savings and benefits where additional equipment may be helpful.
- Instruction of your personnel by experienced technicians in accurate control and test procedures.
- Periodic call-backs by your Bird-Archer Service Engineer to be sure you continue to get the best possible results.

A Bird-Archer 8 Point Service Engineer is only a "phone's throw" away. Call him for greater peace of mind.

BA-800

BIRD-ARCHER

WATER TREATING CONSULTANTS

The BIRD-ARCHER Company, 4337 N. American St., Phila. 40, Pa.

New York • Chicago

The BIRD-ARCHER CO. of California, 415 Brannan St., San Francisco • Offices in Canada and Mexico

For more data circle 541 on Post Card

master meets ASA requirements for 150 lb service with temperatures from −40 to 250 F.

9—Temperature controller can handle up to ten processes

Multi-Point Temperature Controller, developed by Thermo Electric Co., Inc., is announced as providing automatic two-position control for as many as ten separate processes. It can also be used as a single-point controller, a five-point three-position controller and a manual-balance indicator. Any points not being used for control of a multiple-temperature process can monitor other processes. The unit combines a sensitive null-balance potentiometer measuring circuit with an electronic control system and is adaptable to any installation requiring off-on control. Accuracy is given as 0.5 per cent of range. Controls and switches are on front panel. In addition, ten white lights show scanning position, ten red lights show process condition and ten knobs provide for easy setting of controls. The controller is compact — with a 19-by-10½ in. frontal area and a 15-in. depth.

10—Self-adhesive hanger for vertical filing of sheet material

Made of heavy duty press board with a self-adhesive strip already applied, these hangers come in 18- and 36- n. sizes and are notched to fit company's single sheet rack. They can be cut narrower with

scissors. The hangers are introduced by Plan Hold Corp., along with an adjustable size rack that will accommodate 150 of them of any length up to 36 in. Although intended for single sheets, almost any large sheet material can be handled. Pre-drilled holes permit groups of hangers to be fastened together with ⅛-in. paper fasteners. Tracings and vellums can be reproduced with hanger attached. In the 18-in. size, the hangers cost less than $2.00 a dozen.

12—Compact pump boosts system pressures in distributing line

Hydro-Boost, a submersible, turbine type unit designed for continuous duty, provides a means of adding a booster station on lines requiring additional pressure. It is manufactured by Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp. This pump is available with capacities to 8000 gpm, heads to 1000 ft, motors to 350 hp, and can be placed in lines up to 16-in. diam. Offering a number of low cost installation possibilities, the compact Hydro-Boost can be installed vertically or horizontally, usually in a recessed location. Control can be at installation site or at a nearby pumping plant. A by-pass hook-up permits periodic inspection without interruption of service. Bulletin B-703 gives details.

13—Temperature regulators for storage type heating, cooling

Leslie-Eventemp Regulators are introduced by Leslie Co. to meet the need for units that will "full stroke" the valve with a smaller temperature change than for vapor pressure or gas filled type regulators used in storage type heating and cooling services. These are single-seated, self-contained units, diaphragm actuated, with a lever-type internal pilot. There are only two moving parts in the body; no close fitting parts. Temperature variations are sensed by a liquid filled thermo-element which is interchangeable when the regulator is on the line.

These regulators are for continuous or standby service on storage and process heaters and coolers, standpipe heaters, lube oil storage heaters and other applications where it is desirable for heating and cooling to take place at a maximum rate until set point is reached. They can be had with cast iron or bronze bodies, screwed or flat ends, sizes from ½ to 4 in., for inlet pressure to 175 psi, temperature to 500 F.

14—Steam generator is self-contained, automatic

This self-contained, fully automatic, portable steam generator is announced by Clayton Mfg. Co. as a 110-hp oil-fired unit requiring only water and fuel supply. It is designed for general industrial use wherever size, weight and non-availability of electrical power are a factor. Unit operates on forced circulation principle, providing full steam pressure in approximately three minutes from a cold start, company says. It contains its own gasoline engine drive.

15—Self-locking jacketing speeds overhead installations

For aluminum sheathing of overhead insulated lines, Loc-Jac Z-Crimp can be installed by one man, according to manufacturer, Premetco. This aluminum jacketing comes pre-cut and pre-rolled; natural tension of the rolled sections

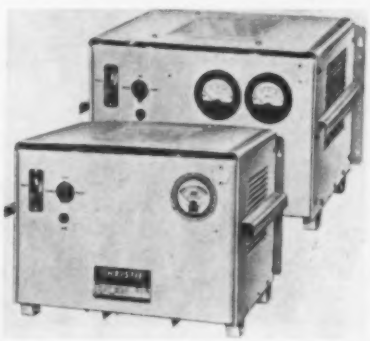
hold it in place until secured. A Z-Crimp along one edge forms a seal with the opposing edge and each section interlocks with adjoining sections to form a continuous seal. No cutters, rollers or special tools are required. Use of this sheathing lets the insulator stagger the insulation and sheathing joints. A 2-in. circumferential overlap of the jacketing provides for natural expansion without separating the joint. The interior surface is moisture proofed by heavy Kraft paper with polyethylene coating bonded to the jacketing. Sections can be joined with pop rivets, screws or bands. Any type insulation can be used.

16—Control cable has thermosetting insulation

Industrial control cable introduced by General Electric Co. has chemically cross-linked polyethylene insulation, called Vulkene, which reputedly combines electrical properties of polyethylene with thermal properties of heat-resistant rubbers. Result is a cable claimed to have improved heat stability and excellent electrical characteristics, better chemical resistance, and smaller diameters. Cable is designed for general usage in air, conduit, underground ducts, or for direct burial, especially high-ambient temperature applications and for long circuits where high-insulation resistance and low capacitance are needed. Cable is spliced and terminated in the same manner as other thermosetting types. It comes in 600- or 1000-v rating, two through 12 conductors, sizes No. 14, 12 and 10 Awg.

11—Automatic chargers for five types of batteries

Christie Electric Corp. announces introduction of Stepless Automatic Battery Chargers Models BC24-50, BC32-25 and BC120-6, which are "tailor made" for each lead-acid, nickel-cadmium, silver-zinc, silver-cadmium or nickel-iron battery application. Charging is reported simple and effortless. The three models cover a wide range of voltage and current ratings, with special characteristics available for applications from float charging batteries for emergency lighting and standby service to heavy duty lift truck charging. Bulletin BC-60-1 describes the chargers.



17—Program controller is round chart, cam operated unit

This electronic controller is designed by Wheelco Industrial Instruments Div., Barber-Colman Co., for automatic reproduction of any predetermined program. Temperature, speed, strain, flow and other variables which can be resolved into a millivolt signal can be controlled in almost unlimited patterns. Full-scale rise can be accomplished in 30-deg rotation. Cam contour is picked up by a cam follower arm; arm position is transmitted through the "electronic link" to the set point which is connected to the control form. The permanent

KEELER CP

MORE STEAM CAPACITY IN LESS SPACE... GREATER FURNACE VOLUME...LOWER COST

The economy of Keeler CP steam generators is described by such user reports as . . ."*Fuel savings approximately $700 per month*". . . "*Reduction of 25% over cost of operating previous boilers.*" And here you see how Keeler builds-in this economy and efficiency.

The CP design gives you more steam capacity per cubic foot of space occupied, greater furnace volume with less head room. Keeler "water walls" provide extra heat absorbing surface—and absorb more BTU's per square foot from the radiant heat of the fire. Staggered tube spacing gives you maximum heat transfer. Free, natural water circulation—without internal baffles—permits operation at high overloads with exceptionally dry steam, and with no disturbance of water level.

Available in capacities to 150,000 lbs stm/hr for any method of firing, all types of fuel (and readily convertible). Many shop assembled sizes. *Write or phone for the full economy story . . .*

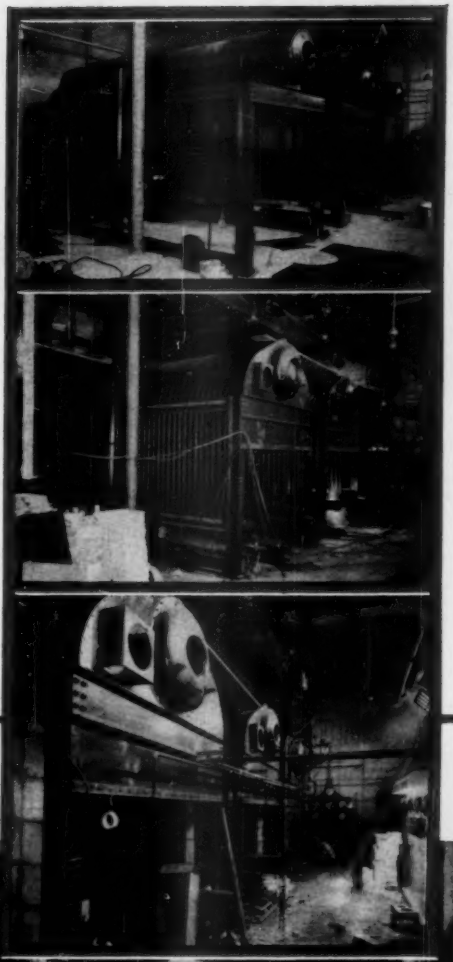
E. KEELER CO. • 100-200 West St., Williamsport, Penna.

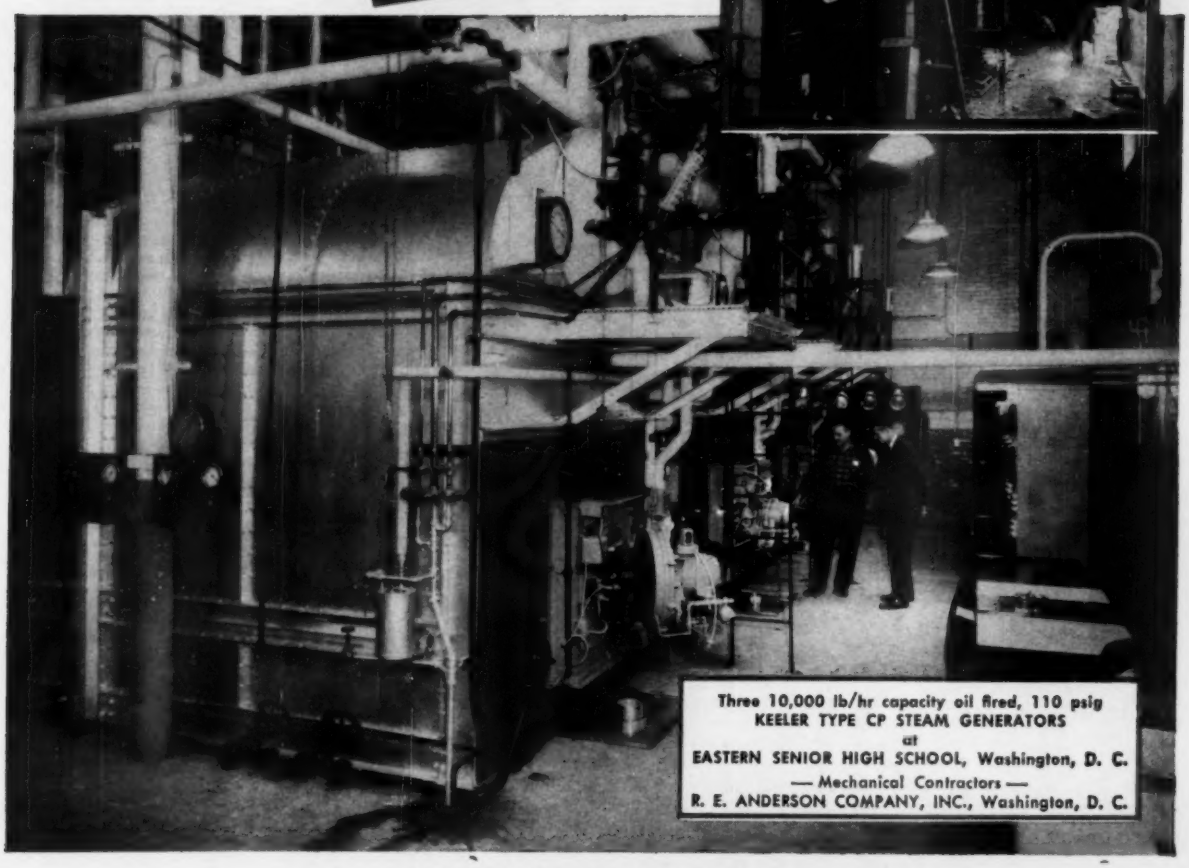
Offices in principal cities — In Canada: Canadian Vickers, Ltd., Montreal, P. Q.

— ESTABLISHED 1864 —

The Seal of Quality in Water Tube Steam Generators

KEELER WATER TUBE Boilers





Three 10,000 lb/hr capacity oil fired, 110 psig
KEELER TYPE CP STEAM GENERATORS
at
EASTERN SENIOR HIGH SCHOOL, Washington, D. C.
— Mechanical Contractors —
R. E. ANDERSON COMPANY, INC., Washington, D. C.

For more data circle 542 on Post Card

FOR STEAM PROCESS EFFICIENCY
WE RECOMMEND

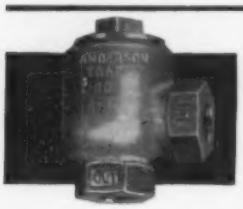
Super-Silvertop
INVERTED BUCKET TRAPS for:

Autoclaves
Bare Pipe
Calenders
Coffee Urns
Convectors
Corrugated Paper Making Machines
Drain Pans
Dress Forms
Drips
Dry Cans
Dryers
Fan Systems
Flat Work Ironers
Header Drips
Hot Water Heaters
Kettles
Pipe Coils
Presses
Sock Forms
Steam Engines
Steam Mains
Steam Tables
Steam Purifiers
Sterilizers
Submerged Surfaces
Tumblers
Unit Heaters
Vacuum Canners
Warmers

Heat-Kwik
COMBINATION TRAPS for:

Autoclaves
Cooking Kettles
Dryers
Expellers
Kettles
Rendering Cookers
Retorts
Slashers
Submerged Surfaces
Tempering Apparatus
Unit Heaters
Water Heaters

or wherever fast heating up is desired



Quik-Flex
THERMOSTATIC STEAM TRAPS for:

Autoclaves
Cooking Kettles
Dryers
Expellers
Kettles
Retorts
Slashers
Sterilizers

or wherever fast heating up, or outside freeze-proof installations are required.

Anderson
FLOAT TRAPS for:

Air Purifiers
Gas Purifiers
Condensate Flow Meters
False Water Line Sewers
Master Trapping Separators
Air Separators
Gas Separators
Air Receivers
Gas Receivers
Gas Scrubbers

or wherever continuous discharge is necessary

Anderson has no "axe" to grind. With a complete line of traps we provide an honest recommendation for all your trap problems. Write for your free book "How to Select Steam Traps" . . . written to give you an unbiased opinion in answer to all your steam trap difficulties.

SUPER SILVERTOPS STEAM TRAPS
BY THE MANUFACTURERS OF Hi-eF PURIFIERS

THE V. D. ANDERSON COMPANY
Division of International Basic Economy Corporation
1997 West 96th Street • Cleveland 2, Ohio

For more data circle 543 on Post Card

chart can be removed without interfering with program cycle. Components are readily accessible and hinged chassis opens wide for easy maintenance. A synchronous motor with start-stop switch drives chart and cam.

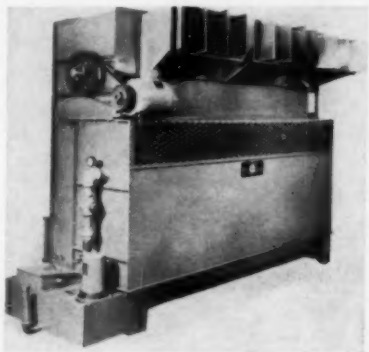
18—Portable insulation tester for the high voltage lines

Model HV53 is announced by Opad Electric Co. as a portable non-destructive high-voltage insulation tester with a continuously adjustable output of zero to 5000 v rms. It features a calibrated

transistorized high voltage circuit breaker with a continuously settable trip point between 10 and 3000 ua. Leakage current in excess of preset value disconnects high voltage from test specimen, illuminates indicator lamp and sounds an audible alarm. Manual, foot switch, or high speed remote control operation is possible. Panel selector switch provides for guarded or unguarded testing. The tester is priced at around $250.00.

19—Spray coolers for room cooling and blast freezing

Series 3900 Spray Coolers of Niagara Blower Co. chill air by passing it across sprayed coils in which a refrigerant is expanded. Air enters above the coil section, passes downward through the spray chamber, over the refrigerated surface and then upward through the fans to the discharge outlets or ducts for distribution. The sprays, either brine or No-Frost liquid, an organic non-corrosive, non-freezing compound, prevent ice formation on the coils. In the No-Frost method the spray solution is automatically reconcentrated — and the units utilize finned coils to increase heat transfer and give higher capacity in relation to unit size. Air capacities range from



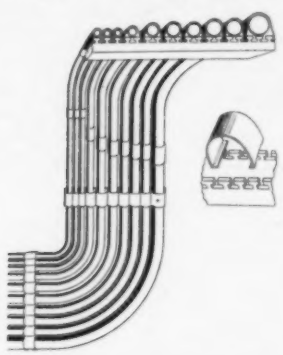
2100 to 24,000 cfm per unit. Cooling capacity is 1660 to 15,700 basic ratings in Btu/hr temperature difference between entering air and refrigerant temperature. A floor mounted model is shown. Low head room units can be had for deck mounting or ceiling suspension.

20—Magnesium dolly handles large reels of wire, cable

Of durable, lightweight magnesium, the Magcoa Cable Reel Dolly introduced by Magnesium Co. of America, has a loading capacity of 2,000 lb, weighs 33 lb. It can be used inside buildings or on open ground. The non-skid, raised-pattern tread of the approach apron serves to provide safe, easy mounting of reels on dolly rollers. The ratchet settings permit adjustment of the rollers for all size reels. The footlock is simple and effective in operation. Nylon ball bearing rollers on each side frame, recessed and under protective shields, permit the reels to revolve. The rollers, with heavy duty bearings, allow up to 30 in. of usable width, and accommodate most reels. When larger reels are handled, two dollies set side-by-side can be used.

21—Hanger for banks of electrical conduit and pipe

Reduced costs, simple and fast installation, and improved construction are claimed for Stamperhanger. Also announced by the Stamperhanger Co. are



one-piece clamps, interchangeability of pipe within the bank without moving adjacent pipe, and automatic alignment that is permanent — even though workmen may step on the pipe. Conduit or pipe is held against a channel iron by spring alloy aluminum clamps which slide over the pipe and are held in by slots in the channel. A cam on the clamp holds it in place.

22—Control units make battery charging automatic

The Exide Automatic Charge Control is designed as a mate for The Electric Storage Battery Co.'s Hi-Lo Chargers used with batteries such as those supplying stand-by or intermittent power for emergency lighting and process equipment. It acts to vary charge rate of rectifier as required by battery and prevent overcharge or undercharge damage. When battery voltage drops below a full-charging value, the control unit puts the charger on high rate. After full-charge voltage is reached, the unit switches the charger back to a low trickle-charge maintenance rate. It

PRESSURES:
2000 psi
TEMPERATURE
1200°F.

DON'T WORRY
THEY'RE PACKED WITH
JOHN CRANE

SEVERE SERVICE PACKING
Style 177AI

Here is the tough, dependable packing you've been looking for. Style 177AI is built to take punishment . . . to easily withstand pressures as high as 2000 psi . . . remain resilient at temperatures to 1200°F. It's a packing that will give you the kind of service you've always wanted in high temperature valves, soot blowers, gauge glass fittings and similar applications.

Style 177AI is dry graphite lubricated to reduce friction to a minimum. Each strand of the closely braided asbestos yarn top jacket is reinforced with Inconel wire. Core consists of long fibre asbestos and flake graphite.

Available in Spools or in Die-Formed Rings. Rings available with either square cross section or with special bevels for concave-convex nest sets.

Get full information on Style 177AI Packing now. Request catalog describing the full line of "John Crane" Packings.

CRANE PACKING CO., 6429 OAKTON STREET, MORTON GROVE, ILLINOIS (Chicago Suburb)

In Canada: Crane Packing Company Ltd., Hamilton, Ont.

John Crane CRANE PACKING COMPANY

For more data circle 544 on Post Card

CRUSHING FACTS
from American PULVERIZER CO.

When You Figure Costs, The Best Results Come From American Coal Crushers

An independent survey of the performance of American Coal Crushers in 29 Mines and Power Plants showed these results:

Total Tonnage — 61,000,000

Average Age of Crusher — 9.5 years

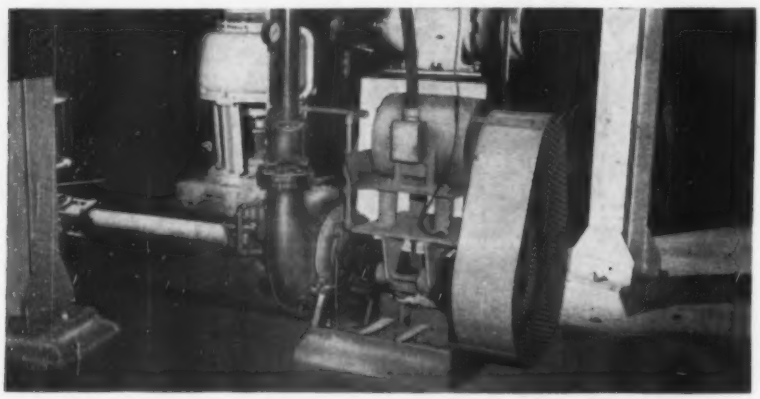
Average Cost of Replacement Parts per Ton of Coal Crushed — $0.0012

There can be no better proof of the built-in quality of American Rolling Ring Coal Crushers.

American PULVERIZER COMPANY
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

1431 MACKLIND AVE. ST. LOUIS 10, MISSOURI

For more data circle 545 on Post Card



Nagle "KR" Pump provides economical disposal of ash from sludge incinerator at Nashville!

This Nagle 4" type "KR" pump provides economical disposal of wetted ash from a sewage sludge incinerator at the Nashville, Tenn., Sewage Treatment Plant. This Nagle Pump is designed to handle this gritty, abrasive material which would soon wear out or clog an ordinary pump. Water end parts are of tough manganese steel. Impeller is readily accessible. Simple slippage seal adjustment. Packing gland within easy reach has trouble "designed out".

Many power plants and waste disposal plants are profiting from the use of Nagle Pumps for ash handling and drainage. Send for Nagle Pump Selector. Nagle Pumps, Inc. 1229 Center Ave., Chicago Heights, Ill.

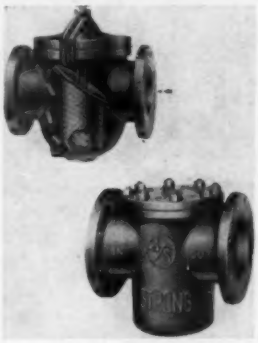
Tough jobs call for
Nagle PUMPS
FOR ABUSIVE APPLICATIONS EXCLUSIVELY

For more data circle 546 on Post Card

checks on the state of battery charge every hour. Only routine maintenance, no manual adjustment, is required, says manufacturer, and components are mounted on the door of a steel cabinet where they're readily accessible. The control unit can be designed for use with any Hi-Lo Charger for any number of lead-acid or nickel-cadmium cells.

23—Basket strainers protect pumps, valves, regulators

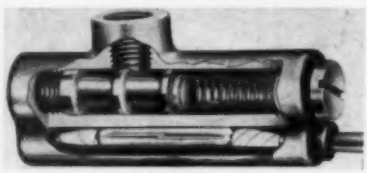
Four low-cost basket strainers are announced by Strong, for use in steam, air, oil, gas and chemical lines for catching dirt, foreign matter and pipe cuttings. They are also suggested for most suction



and high or low pressure installations. In semi-steel and cast steel, these strainers have clamped or bolted covers. The former are suitable for most applications and facilitate cleaning. Bolted covers are supplied for applications subjected to pressure to 600 psi at 800 F. Sizes range from 2 to 16 in. with flanging from 125 to 300 lb. Baskets are brass or stainless steel. Bulletin SM-70 gives details.

24—Flow switch actuates on preset flow rate

The FS-925 Flow Switch, product of The Gems Co., Inc., is described as highly sensitive and dependable for



detecting flow or lack of flow in small piping and tubing systems. Low cost, low capacity unit that actuates on a preset flow rate may be used to operate a remotely located indicator, visual or audio; or through automatic interlock, control pump motors through suitable relays. Installation is simple. The ¼-in. NPT ports permit use of standard piping, or can be adapted to tubing requirements.

25—Chain drives for gas turbine power transmission

For transmitting power of 30- to 1800-hp gas turbine engines, Hy-Vo (high velocity-involute sprocket) Chain is announced as a refinement of the silent chain principle for high speeds and heavy loads. It incorporates compensating links to eliminate chordal action.

PALMER

Mercury Actuated Dial Thermometers now in three types to suit any requirements

PATENTED
FULL 4½" DIAL FACE. Stem can be placed at any angle and case can be rotated to any readable position.
1 RIGID STEM DIAL THERMOMETER tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)
2 WALL MOUNTED DIAL THERMOMETER with flexible connecting armor. Case adjustable to easy reading position.
3 FLUSH MOUNTED DIAL THERMOMETER for panel mounting with flexible connecting armor.
ALL THREE TYPES HAVE A FULL 4½" DIAL FACE.

■ **for accuracy:** Mercury actuated . . . Compensated by Invar. Guaranteed Accurate 1 scale division. ■ **for angularity:** Can be adjusted to most readable position at any angle desired. ■ **for readability:** Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position. ■ **for interchangeability:** Also specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

PALMER

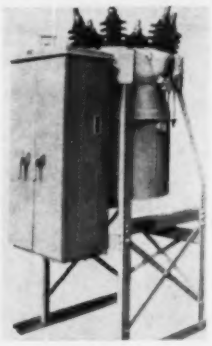
PALMER THERMOMETERS, INC.
Norwood Ave., Cincinnati 12, Ohio
MFRS. OF INDUSTRIAL LABORATORY, RECORDING AND DIAL THERMOMETERS

For more data circle 547 on Post Card

According to Morse Chain Co., this chain is suited for driving auxiliaries of two-shaft gas turbines. Typical applications include powering: heat regenerators, lubricating oil pumps, alternator or generator, cooling fan, governor, power takeoff, and starters. Hy-Vo is offered to fill the power transmission gap between low speed roller chain not applicable to gas turbines and high-speed gearing, it is stated. Additional features cited include versatility (any combination of center distances and compounding requirements can be handled with stock pitches); low peripheral speed; better load distribution; low speed capacity. Pitches range from ¾ to 2 in., widths from 2 to 24 in.

26—Power circuit breaker is compact, low-maintenance unit

Type AD-28, a single tank oil circuit breaker with ratings of five cycle, 100, 250 and 500 mva for 14.4 kv and below, is introduced by Federal Pacific Electric Co. Taking up less space and requiring less maintenance and installation time than many similarly rated units, this outdoor breaker is designed to open and/or close on three-phase electric



current in the 4- to 15-kv range for protecting against system damage. Chief feature is small size — 8 ft 3 in. high, 3 ft 10 in. wide and 3 ft 9 in. long. To install it, little more than 15 sq ft of ground area is required. You can increase substation capacity without rebuilding the station.

Another feature announced is fewer parts — the Ad-28 has only half the usual number of moving and stationary contacts. Also noteworthy is an entrance bushing consisting of a simple porcelain tube assembly. Mounting is through the use of dual conical clamping surfaces lined with cork Neoprene, which provides sufficient resilience to prevent damaging impact loading of the porcelain. Energy requirements are low — including motor, only 15 amp for a 5 sec maximum at 48 v d-c.

27—Belt splice is heavy-duty, reversible, hinge type

Conveyor belts having interwoven carcass may be spliced without drilling or hole-punching by means of the Minet Splice. This heavy-duty, hinge-type splice is designed for installation in one piece. As the conveyor operates, the hinge plate separates into sections at pre-scored notches to conform with trough curvature. High strength is attributed to the fastening method employing pointed rivets which separate but don't cut belt fabric. Manufacturer

LARSON-LANE STEAM AND CONDENSATE ANALYZERS

FOR ACCURATE MEASUREMENT OF STEAM CONDUCTIVITY

MOST modern and efficient system of removing volatile amines, ammonia and carbon dioxide prior to recording steam conductivity. This thoroughly effective steam degasser uses a cation exchange resin for the removal of ammonia, morpholine, cyclohexylamine, and reboiling for the removal of CO_2. Constant sample temperature is maintained. Taps provided for drawing sample for other analyses.

Larson-Lane Steam and Condensate Analyzers make possible rapid and accurate measurement of steam purity, completely essential for efficient boiler operation.

A smaller, less expensive unit, the CH-16 provides for removal of ammonia and amines from steam condensate without the necessity of reheating. Condenser leakage is readily detected with this model in the presence of volatile amines or ammonia.

Write today for complete technical details.

Industrial Instruments Inc.
89 Commerce Road, Cedar Grove, Essex County, N. J.

For more data circle 548 on Post Card

WHY GAMBLE with an OLD STYLE PUMP?

- No Floats to adjust
- No Rods to foul up
- No Water Level Worries

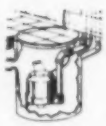
WITH

KENCO Completely Submersible PUMPS

Model 109

Approved

Compact
Easy to hide
- under the floor
- out of the way
- out of sight!



Model 140

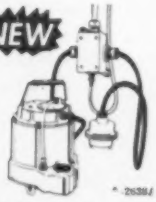
Easiest to Install!
Just plug it in and it's ready to go—no tricky float adjusting, no water level worries.

NEW

3-phase 230-volt Industrial Pump
Model 330

NEW

Variable Turn-On Heavy-Duty Pump
Model 119-VTO



See Your Wholesaler!
Complete Line — 600 to 6000 GPH

KENCO PUMP
Division of The American Crucible Products Co.
1305 Oberlin Avenue • Lorain, Ohio

For more data circle 549 on Post Card

says that this splice, with reusable cable pin, can go around small diameter pulleys. It's available from General Splice Corp. for belts from 1/32 to 1 in. thick, up to 72 in. wide.

28—Air vibrator speeds unloading of hopper cars

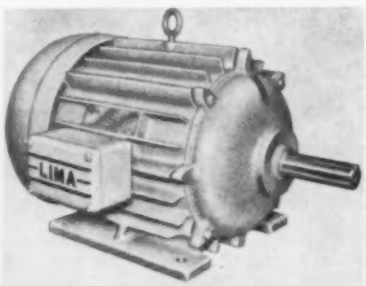
The Navco HCP line of heavy-duty air vibrators for unloading covered railroad hopper cars is designed with an exceptionally long piston stroke for maximum amplitude and thrust, and the piston is

the only moving part. According to National Air Vibrator Co., units reduce unloading time, eliminate "clean-out" of cars after emptying. Two models are available — the 3-in. piston size is 14¼ in. long, weighs 68 lb and consumes 18 cfm at recommended air pressure of 40-60 psi; the 4-in. piston size is 17½ in. long, weighs 115 lb, and consumes 29 cfm at 40–60 psi.

Described on these pages are new and improved products. Use Reader Service Cards on pages 93–94 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

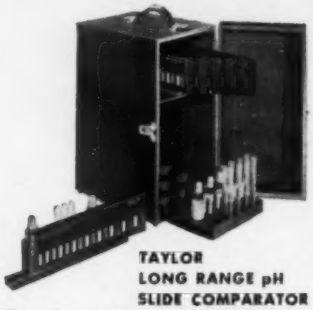
29—Brushless generator features inherent voltage regulation

According to The Lima Electric Motor Co., Inc., the FCE Generator is a brushless d-c excited a-c generator with minimum voltage dip and fast response characteristics to provide operation of a polyphase squirrel cage induction motor (Nema B) having a horsepower rating equal to the generator kw rating and using a standard magnetic across-the-line motor starter. A rotating induction

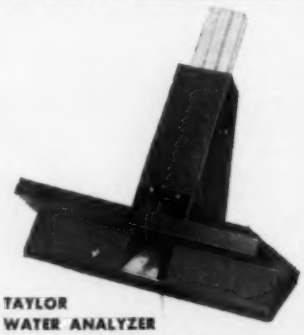


WHAT'S IDENTICAL ABOUT THESE TAYLOR COMPARATORS?

ALL GIVE YOU FAST, EASY, ACCURATE TESTS to aid power plant operations



TAYLOR
LONG RANGE pH
SLIDE COMPARATOR
Contains any 7 color standard slides in the 3 to 9 pH range. Range can be increased with additional standards.



TAYLOR
WATER ANALYZER
For accurate tests of pH, condensate silica, hydrazine, morpholine, total iron, copper and many others.

TAYLOR
HIGH PHOSPHATE COMPARATOR
For controlling internal conditioning and hot phosphate softeners.

ALL TAYLOR COMPARATORS HAVE GUARANTEED NON-FADING COLOR STANDARDS

SEE YOUR DEALER for Taylor Sets or immediate replacement of supplies.

FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes full Taylor line.

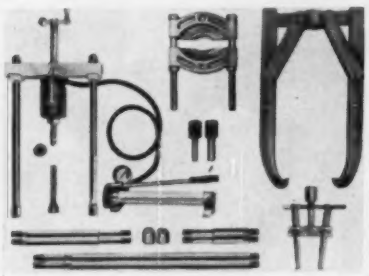
W. A. TAYLOR AND CO.
410 STEVENSON LANE • BALTIMORE 4, MD

For more data circle 550 on Post Card

exciter provides an inherent voltage regulation of ±5 per cent and with no external controls. The unit has no slip rings or brushes, is enclosed, fan cooled.

30—Hydraulic maintenance sets for the basic pulling jobs

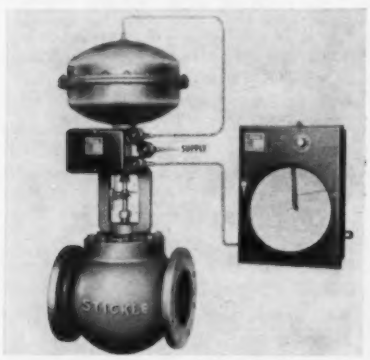
These three sets of Owatonna Tool Co. contain rams, pumps and attachments required for removing and installing



gears, bearings, bearing cups, sheaves, shafts, couplings, sprockets, pulleys, wheels. For small and medium equipment, Set Y200-A contains a 17½-ton ram; for medium and light-heavy equipment, Set Y265-A (shown) contains a 30-ton ram; and for heavy equipment, the rugged Set Y-285, a 50-ton ram.

31—Recording controller for pressure or temperature service

This recording type controller is designed by Stickle Steam Specialties Co. to maintain any desired pressure or temperature by regulating flow of steam



or liquid through a diaphragm motor valve. Accuracy is said to be ±1 per cent of total span. Operating the controller is a sensitive air measuring system actuated by a process temperature or pressure measuring system. To prevent cycling, instrument has a 1 to 10 per cent proportional band adjustment with manual reset. A 12-in. circular 24-hr chart records with one or two pens.

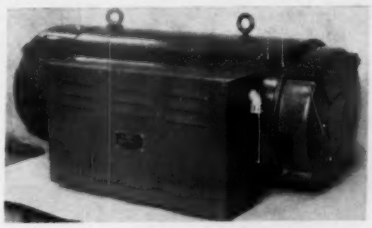
32—Two-speed cable puller weighs only 29 lb

With the lightweight No. 766 Cable Puller only 30 lb of handle pressure is required to pull 1500 lb, it is announced. A product of Greenlee Tool Co., the unit features two-speed operation with three-to-one and nine-to-one ratios. It is designed to fit all outlet boxes and is equipped with 200 ft of steel cable. Winch ratchet action plus open-side construction of the pulley support also

contribute to operating efficiency. The frame is high tensile square tube construction to stand heavy pulls and constant usage.

33—Motor-generator supplies uninterrupted power

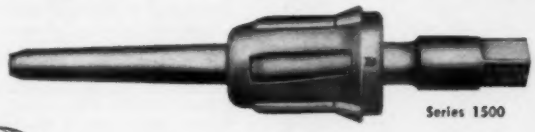
This motor-generator set, designed by Allis-Chalmers Mfg. Co. to supply uninterrupted power for microwave repeater stations, consists of a Synduction motor, a d-c motor, a single phase generator and exciter with common yoke. During normal operation, the Synduction motor drives the generator with input from commercial sources and d-c motor on standby. Fields and brushes are energized from 120-145-v battery, with brushes removed from commutator by



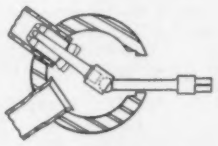
WIEDEKE

THE QUALITY NAME IN TUBE EXPANDERS . . . SINCE 1892

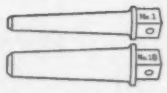
Tube Expanders for Water Tube Boilers



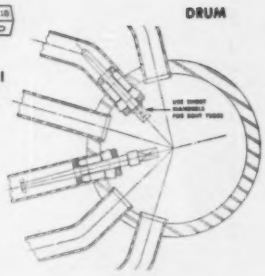
Series 1500



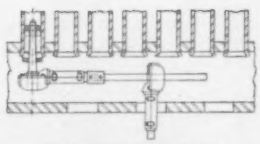
With Short Mandrel; Universal Joint Drive for Superheater Header.



Short Mandrels—all sizes, in 3 lengths



With drum Mandrel for straight tubes; use short Mandrels for bent tubes.



With Short Mandrel and Right Angle Gear Drive; for round or square headers.

#38

IDEAL

Continuous research and development in Tube Expanders, Tube Cutters and Operating Accessories for condensers and boilers has been going on at The Gustav Wiedeke Company since 1892. The IDEAL Trademark is your guarantee of quality. *Confidence* is your assurance that your job will be done *RIGHT* . . . when you use WIEDEKE Specialized Products. Wiedeke Distributors in principal cities. Write for *new* General Catalog 81.

The Gustav WIEDEKE Company

Dayton 1, Ohio

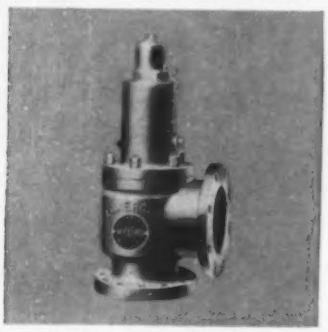
THE LONERGAN LINE

HOW TO SAVE WEAR AND TEAR ON MEN AND VALVES

by A. J. Schmidt, Chief Engineer

Power plant users of relief valves in liquid service are undoubtedly all too familiar with chattering. Valves hammer away, annoying plant personnel and running up maintenance bills.

Even with this undesirable operation, these



valves have been acceptable for application where the valves are seldom, if ever, called upon to relieve. For use under critical applications, such as pump-by-pass, where the valve is normally open, or where opening is a common occurrence, it has been necessary to use expensive diaphragm or piston operated valves to eliminate objectionable chattering.

A new series of valves, called Lonergan Hydro-Valves have been under test in dozens of leading plants for the past three years. As a result, Lonergan can provide power plant operators with a valve that is guaranteed not to hammer, chatter or drum on any application, by-pass or emergency relief. At the same time, full-rated liquid flow is maintained. The chatter free operation is provided by a patented, unique design of throat, seat and baffle construction. Use of the Hydro-Valve helps to: save human nerves; prevent loss of plant fuel or product; reduce maintenance on valves and piping; and eliminate interference with delicate control systems. Hydro-Valves are available in all regular body and trim materials in sizes ranging from 1 to 8 inches.

Full details and descriptions are available in our new Hydro-Valve bulletin. Why not write for your copy today?

Alvin J. Schmidt

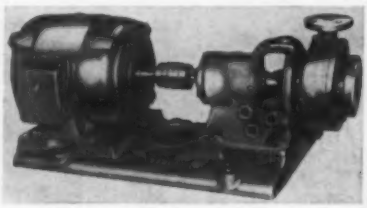
Lonergan

J. E. LONERGAN CO., 207 RACE STREET
PHILADELPHIA 6, PA. SINCE 1872

mechanically linking them to solenoids connected to same source supplying Synduction motor. Should power fail, solenoids are de-energized and brushes drop to commutator, transferring load to d-c motor. When commercial power is restored, solenoids lift brushes from commutator and Synduction motor again becomes prime mover.

34—Centrifugal pumps for handling of difficult fluids

Model 3199 Pumps, available in two sizes, are designed to meet requirements in chemical process and other industries where relatively small quantities — up to 115 gpm — of corrosives or slurries, thick or abrasive, must be handled for heads up to 150 ft. Products of Goulds Pumps, Inc., they are single stage side suction, open impeller pumps with 1-in.



flanged discharge and 1- and 1½-in. flanged suction connections. Standard assembly provides top vertical discharge but horizontal top or bottom discharge position is also available. Impellers have ejector vanes on back wall to prevent entrance of solid material and reduce stuffing box pressure. Stuffing box has five rings of dieformed packing and lantern type liquid seal rings. Tapped in-and-out openings to seal ring allow use of clear liquid seal, clear liquid flush or grease seal to solve individual packing problems when pumping slurries. Pumps come in bronze fitted, all iron, all bronze, 316 stainless steel and Gould-Alloy 20. Full information is in Bulletin 7205.

35—Safety shield can be used in shop or on the job

This low cost, lightweight safety shield offers protection in welding, grinding, cutting operations or as a dividing partition. Company says it can be assembled or taken apart in 3 min. without tools, has no hooks, screws, bolts or wires. A fire-resistant duck curtain wraps around the rust-proof, black oxide finished steel frame with snap fasteners. It is available in four sizes up to 36 in. high, and 72 in. wide, from Singer Glove Mfg. Co.

UNCROSSES FINGERS!

Yes, you uncross your fingers . . . you don't take chances . . . when you buy CONSECO Equipment, even when it doesn't cost most! A sweeping statement . . . but we feel our more than 33 years of experience amply justifies it. So does every CONSECO customer. So *will you.*

CONSECO

DESIGNS • BUILDS • ENGINEERS
DELIVERS • INSTALLS • MAINTAINS

All Condensing, Feedwater Heating, Evaporating, Air Removal and Condensate Cooling Equipment for any Thermal Power Generating Plant.

CONDENSERS • EVAPORATORS
DEAERATORS • HEAT EXCHANGERS
FEEDWATER HEATERS
STEAM JET AIR EJECTORS

Over a third-century of experience

CONDENSER SERVICE & ENGINEERING CO., INC.

158 Observer Highway,
Hoboken, N. J.

Hoboken Telephone:
OLdfield 9-4425
N.Y.C. Telephone:
BArclay 7-0600

Send for Latest Steam Condenser Bulletin. ▶

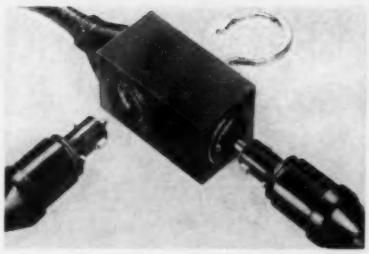
For details see Chemical Engineering Catalog

Bulletins on all CONSECO PRODUCTS sent on request

36—Instrument provides continuous on-stream water analysis

Introduced by Hagan Chemicals & Controls, Inc., the Chemonitor duplicates continuously and automatically the principles of colorimetric analysis, thus determining and recording the amount of a specific component in water. A sample is piped into instrument and mixed with reagents. When silica is present, the sample turns blue. Intensity of color is then measured by the colorimeter and the measurement recorded on a recorder. When desired, the recorder operates an upper-limit switch which, in turn, actuates an alarm system. In the zero to 300

ppb silica range, the Chemonitor permits detection of concentrations as low as 5 ppb with ±2 ppb accuracy. Typical applications are analysis of boiled water, condensate and effluents from demineralizers, water softeners, and waste disposal treatment plants. The Chemonitor can be set up to conduct single or multiple point analysis. In the latter, as many as four points can be analyzed as frequently as desired.



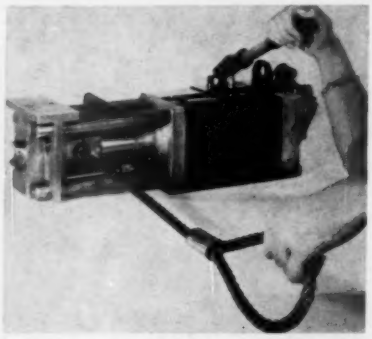
37—Plugs and receptacles for use in hazardous locations

Explosion proof Industriline Plugs and Receptacles are announced by J. B. Nottingham & Co., Inc., for safe, rapid connection and disconnection of electric lighting and power distribution systems in hazardous areas. Units may be used with two, three or four-wire circuits rated up to 240 v, 15 amp or 120 v, 30 amp. Contacts of electrical-grade copper are encased in Neoprene bodies. It is pointed out that when a plug is inserted into a receptacle, a lip on the former fits a collar on the latter to form a sealed chamber in which contacts engage and close circuit making it impossible for spark to ignite explosive atmosphere. Blocks with four and six receptacles are also available.

Reader Service Cards on pages 93–94 make it easy to get further product information.

38—Small machine repairs cable, makes slings on the job

Mighty Mark is described by manufacturer, Mark Naught, Inc., as a pint-size cable processing unit that cuts and repairs cable, makes slings, eyes, chokers and splices right on the job. A self contained portable hydraulic press, it comes in two sizes, the smaller of which weighs under 70 lb yet exerts 15 tons of pressure and handles cable up to ½ in. A larger size handles larger cable. Hydraulic pressure is generated by manipulation of a 9-in. hand lever and operation is



claimed fast and simple. An inherent feature of an opening clear through the machine for use in choker work gives it additional value where pressure is needed; it can be utilized as a hollow tube arbor press. Manufacturer points out that the unit eliminates cleaning or tinning of cable before processing and that it cuts without fraying.

CLASSIFIED ADVERTISING

For Sale

IMMEDIATE DELIVERY

York "Turbopak" open-drive centrifugal water chilling system. Model L95-28B-38A. 300 H.P., 4800V, 3 phase, 60 cycle, 0.8 L.P.F. synchronous motor drive with direct connected exciter. Full voltage starter. Electronic control panel. 361 ton capacity with 855 GPM CH.W at 45° and 1080 GPM condenser water at 80°. 10° water temperature rise. This equipment has never been in service.

Columbia Broadcasting System, 7800 Beverly Boulevard, Los Angeles, California, OLive 12345. ATTN: Mr. F. V. Larkin.

Westinghouse 75KW steam turbo-generator, operated less than 300 hours; purchased new 1954. Mint-new condition may be purchased for write-off price. May be inspected. Fayette County Hospital, Vandalia. Illinois.

Services

Physicist (PhD). will consult at your plant. Box 1738 POWER ENGINEERING, 308 East James Street, Barrington, Ill.

At the Air Force Academy...

Sure PROTECTION

FOR THEIR HIGH-PRESSURE SYSTEM

Air Force Academy's extensive heating system is protected and silenced by Williams-Hager Check Valves which operate instantly when flow reversal starts or when flow is zero.

Williams-Hager Silent CHECK VALVES

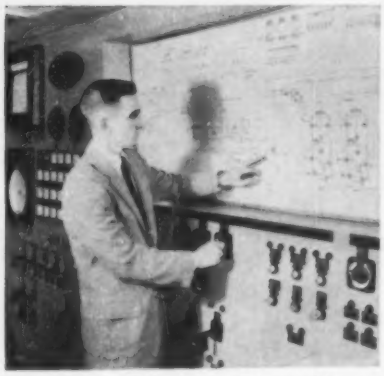
WRITE FOR BULLETINS: No. 659 on Pressure Loss Tests . . . No. 654 on Valves . . . No. 851 on Cause, Effect and Control of Water Hammer

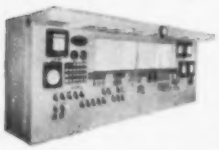
The WILLIAMS GAUGE CO., Inc.
143 Stanwix Street
2 Gateway Center • Pittsburgh 22, Pa.
Our 75th Year • 1886-1961

For more data circle 554 on Post Card

METROPOLITAN EDISON uses...

ILLCO-WAY ionXchange





This graphic control panel, designed and built by IWT, not only has all the controls but also a schematic diagram with indicating lights to show the action at all points.

Blowdown Unnecessary In a New High-Pressure Once-Through Boiler

The Portland Station of Metropolitan Edison Company at Portland, Pa., has a once-through type of boiler for which the purity of make-up water is particularly critical. IWT Mixed-Bed* De-Ionizers were selected to purify the make-up water to the required degree — and they succeeded, even beyond expectations. The total silica in the boiler water is consistently maintained at 0.1 ppm or less. From the Mixed-Bed* De-Ionizer, the silica is normally below 0.01 ppm and log sheets frequently show analyses as low as 0.003 and 0.005 ppm. With such a high purity of make-up water, blow-down is entirely unnecessary for extended periods of time. All IWT equipment — including chemical feeders, gravity filters, cation and anion exchangers, a vacuum degasifier, and the Mixed-Bed* De-Ionizers — are controlled *automatically* from the graphic panel shown above.

* U.S. Pat. Nos. 2,605,084, 2,771,424

PIONEERING EXPERIENCE

Such outstanding performance is the result of intensive early and continuing experience, by Illinois Water Treatment Co., with the special problems of ion-Xchange. *To benefit from this leadership, call your IWT representative.*

ILLINOIS WATER TREATMENT CO.
840 CEDAR ST., ROCKFORD, ILLINOIS
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

For more data circle 555 on Post Card

Advertisers' Index

Aerovent Fan Co., Inc.	*
Air Preheater Corp., Inc.	29
Airetool Mfg. Co., The	91
Aluminum Company of America	*
American Chain & Cable Co. Automotive & Aircraft Div.	*
American Pulverizer Co.	102
American-Standard Industrial Division	*
Ames Iron Works, Inc.	85
Anaconda American Brass Co.	5
Anderson Co., V. D.	100
Armstrong Machine Works	36
Atomics International	*
Automotive & Aircraft Div. American Chain Cable Co.	*
Babcock Wilcox Co., The Boiler Div.	Cover II-1
Bailey Meter Company	10-11
Barco Manufacturing Company	87
Beckman Instruments, Inc.	110
Betz Laboratories, Inc.	16-17
Biddle Co., James G.	*
Bird-Archer Co., The	97
Blaw-Knox Co.	86
Buell Engineering Co.	24
Bussman Mfg. Co.	*
Byron Jackson Pumps, Inc.	*
Cambridge Instrument Co., Inc.	110
Combustion Engineering, Inc.	26-27
Condenser Service & Engineering Co., Inc.	106
Copes-Vulcan Div., Blaw-Knox Co.	22-23
Crane Co.	88, 89
Crane Packing Co.	101
Dean Brothers Pumps Inc.	*
Dearborn Chemical Co.	7
De Laval Steam Turbine Co.	*
Detroit Stoker Company	77
Diamond Power Specialty Corp.	14-15
Eagan Co., Inc., Walter H.	*
Eastern Gas & Fuel Associates	34-35
Edison, Thomas A.	*
Edward Valves, Inc.	*
Elliott Co.	*
Ellison Draft Gage Co.	*
Engineer Co., The	97
Erie City Iron Works	*
Everlasting Valve Co.	12
Fairmount Chemical Co., Inc.	*
Foster Wheeler Corp.	38-39
Fuller Co.	*
General Coal Co.	*
General Electric Co.	*
Globe Co., Products Div.	*
Goodall Rubber Co.	*
Grinnell Co.	*
Hagan Chemicals & Controls, Inc.	33, 90
Hall Laboratories	*
Hoffman Specialty Mfg. Corp.	*
Illinois Water Treatment Co.	108
Industrial Instruments, Inc.	103
Island Creek Coal Sales Co., The	Cover III
Johns-Manville	*
Johnson-March Corp	*
Joy Mfg. Co.	2
Keckley Co. O. C.	*
E. Keeler Co.	99
Kenco Pump Div.	104
Kirk & Blum Mfg. Co.	*
Koppers Co., Inc.	*
KOR	*
Leslie Co	*
Lonergan Co., J. E.	106
Manning Maxwell & Moore, Inc.	28
Marley Co.	*
Mansfield & Green, Inc.	*
Milton Roy Co.	9
Moore & Co., Samuel	*
Morton Salt Co.	81
Murray Iron Works Company	*
Nagle Pumps, Inc.	102
Nalco Chemical Co.	37
Niagara Blower Company	*
North American Mogul	*
Norwalk Co., Inc.	*
OPW-Jordan Corp.	*
OXI Corp.	*
Pacific Pumps, Inc. A Division of Dresser Industries, Inc.	83
Palmer Thermometers, Inc.	103
Peabody Coal Co.	20
Peabody Engineering Corp.	*
Pfaudler Permutit Inc.	*
Pfizer & Co., Chas.	*
Pickands Mather & Company	13
Pittsburgh Corning Corp.	*
Pittsburgh Piping & Equipment Co.	*
Powell Valves, Wm.	95
Powers Regulator Co., The	*
Pratt Co., Henry	*
Quickdraft Corp.	*

Firms whose advertising is not in this issue but is appearing in other issues are marked with an *

Raybestos-Manhattan, Inc. ..... *
Refractory & Insulation Corp. ..... *
Reliance Gauge Column Company ..... *
Research-Cottrell, Inc. ..... *
Riley Stoker Corporation 18-19
Roto Div. of Elliott Co. 109

Sarco Company, Inc. ..... *
Seiscor Div. ..... *
Solar Aircraft Co. ..... *
Spence Engineering Co. ..... *
Standard Oil Co. (Indiana) ..... *
Stickle Steam Specialties Co. ..... *
Stone & Webster Engineering Co. ..... *
Superior Combustion Industries, Inc. 92

Taylor & Co., W. A. 104
The Terry Steam Turbine Co. 30

Union Iron Works ..... *
Universal Atlas Cement Co ..... *

Valley Camp Coal Co., The ..... *
Vogt Machine Co., Henry 25

Western Chemical Company ..... *
Western Precipitation Corp. ..... *
Wiedeke Co., The Gustav 105
Williams Gauge Co. 107
Wilson, Inc., Thomas C. ..... *
Worthington Corporation ..... Back Cover

Yarnall-Waring Company 44, 79
Yuba Consolidated Industries, Inc. 21

District Sales Offices

OFFICERS AND BUSINESS STAFF

President	Arthur L. Rice, Jr.
Vice President	Edwin C. Prouty, Sr.
Vice President and General Sales Manager	James B. Tafel
Secretary and Director of Circulation	Edwin C. Prouty, Jr.
Treasurer	Richard H. Randau
Production Director	John O. Aarvold
Production Manager	Earl R. Noren
Assistant Advertising Manager	Josephine Gear
Research Manager	Margaret Hoagland
Technical Assistant to President	Andrew W. Kramer

DISTRICT MANAGERS

Chicago 3, Ill. 110 S. Dearborn St.	Robert R. Anderson DEarborn 2-5453
Margaret Conerty, Office Administrator	
New York City & New England	William H. Relyea, Jr.
Caroline Friz, Office Administrator	
842 Graybar Bldg. New York 17, N. Y.	MUrray Hill 5-3779
Philadelphia, Pa., and New Jersey 15 Sunrise Drive Morris Plains, N. J.	Joseph E. Halloran JEfferson 8-7873
Pittsburgh 19, Pa. 404 Frick Bldg.	Robert J. Kiesel COurt 1-4940
East North Central 2120 Shenandoah Road Toledo, Ohio	William B. Davis JEfferson 6-7947
California 1145 Wellington Ave. Pasadena, Calif.	Connie J. Grabb, Jr. MUrray 1-6004
Southeast [illegible]ghth St., N. E. Atlanta 9, Georgia	J. Sidney Crane TRinity 2-6720

WESTERN SALES OFFICES

McDonald-Thompson Offices:	
Seattle 4, Wash. 1008 Western Ave.	Harry Abney MAin 3-3766
Denver 3, Colo. 620 Sherman St.	Robert Heidersbach TAbor 5-3325
Houston 6, Texas Room 214, 3217 Montrose Blvd.	Frank Vickrey Jackson 9-6711
Dallas 19, Texas 2727 Oak Lawn Ave.	Parker Harris LAkeside 1-1266

FOREIGN SALES OFFICE

Great Britain 151 Fleet Street	Brayton Nichols, Director London E C 4, England

The American Magazine Group

Quiet, Efficient, Convenient

Ideal for Hospitals, Hotels, Apartments, and Industries where noise is objectionable.

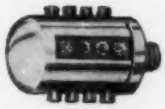
Rotojet Electric Tube Cleaner thoroughly cleans straight tubes from 25/32" to 4" I.D. in boilers, condensers, evaporators, and heat exchangers so quietly that it can be operated without disturbing anyone.

This self-contained unit comprises a powerful motor, rotatably mounted on a stand, a required length of heavy duty flexible shaft, a 20 ft. cable, and a selection of heads, brushes, drills, and scrapers to meet any cleaning need. The motor swivels and rotates so that tubes on top, bottom, and sides can be cleaned without moving the unit. A few of the many types of heads available are shown below.

Bulletin 107 gives full details of this quiet, efficient, convenient tube cleaner. Send for it now.

Rotojet Electric Tube Cleaner with swing-frame head.

4-way drill and universal coupling.



Expanding wire brush.

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

1071-47 Bristol Road, Mountainside, N. J.

For more data circle 556 on Post Card

1

First...for continuous, efficient pH control

to prevent costly corrosion and scale deposition...modern steam power plants rely upon *one* name...the *leader* in development and production of *advanced* pH instrumentation for 25 years **Beckman**®

Scientific and Process Instruments Division
Beckman Instruments, Inc.
Fullerton, California

Beckman pH sales and service is foremost in North America—3 strategic parts locations—electrodes available from more than 100 scientific apparatus dealers—field engineering in over 300 branches of leading recorder companies. Write for Data File 78-3-06.

For more data circle 557 on Post Card

CHECK BOTH

OXYGEN in the feedwater | **HYDROGEN** in the steam

OXYGEN is well known to be an active source of boiler corrosion. The oxygen dissolved in feedwater is determined directly and continuously recorded upon the Cambridge Dissolved Oxygen Recorder.

The oxygen set free by dissociation of the water in the boiler is equally damaging. Its presence is determined by measuring the free hydrogen in the steam condensate. Cambridge Analyzer-Recorders provide continuous records of both the oxygen dissolved in the feedwater and the hydrogen in the steam—on one chart if desired, thus enabling prompt corrective measures to be taken.

Complimentary copies of these bulletins will be sent upon request.

A. S. T. M. BULLETIN D1588-58T
CAMBRIDGE BULLETIN NO. 146 BP

Instrument shown here may be used to record either O_2 or H_2 or both simultaneously. Cambridge also makes Hydrazine Analysers, PH Recorders and Instruments for analyzing gaseous mixtures.

CAMBRIDGE INSTRUMENT CO., INC.
1678 Graybar Bldg., 420 Lex. Ave., N.Y. 17, N.Y.

CAMBRIDGE
Dissolved O_2 & H_2
ANALYZERS

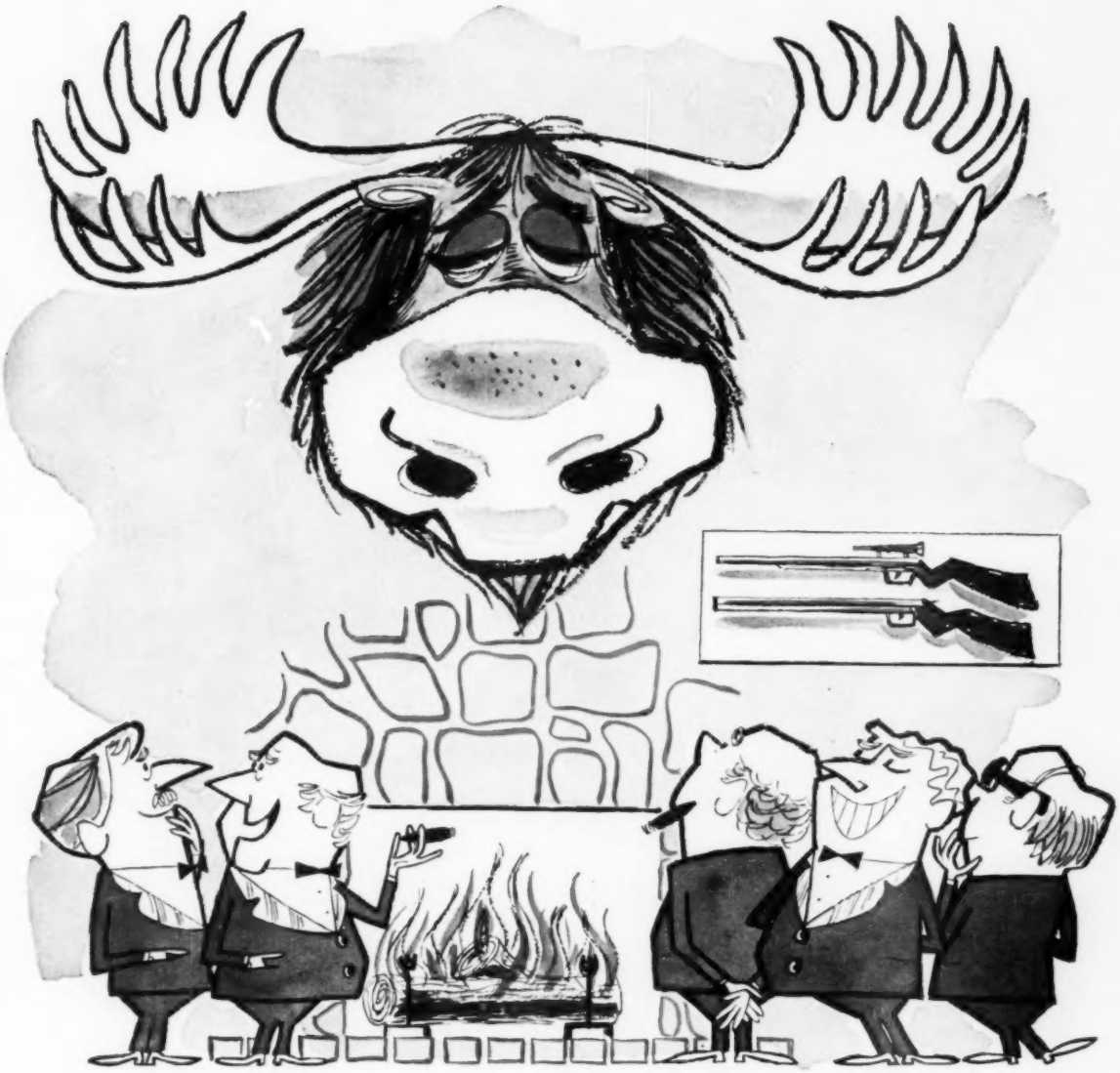
Pioneer Manufacturers of Precision Instruments

For more data circle 558 on Post Card

The easiest—and quickest—way to order bulletins and catalogs described in this magazine is to use the postage-free Reader Service Cards on pages 93–94.

All you need to do is circle the item numbers of those you want. Then fill in your name, job title, company name and address—and mail the card.

You may also use the Reader Service Cards to request information on products described, or literature mentioned in the ads—just circle the number below the ad.



"The only thing Fred would rather talk about is how he discovered the way to lower the cost per 1000 pounds of steam."

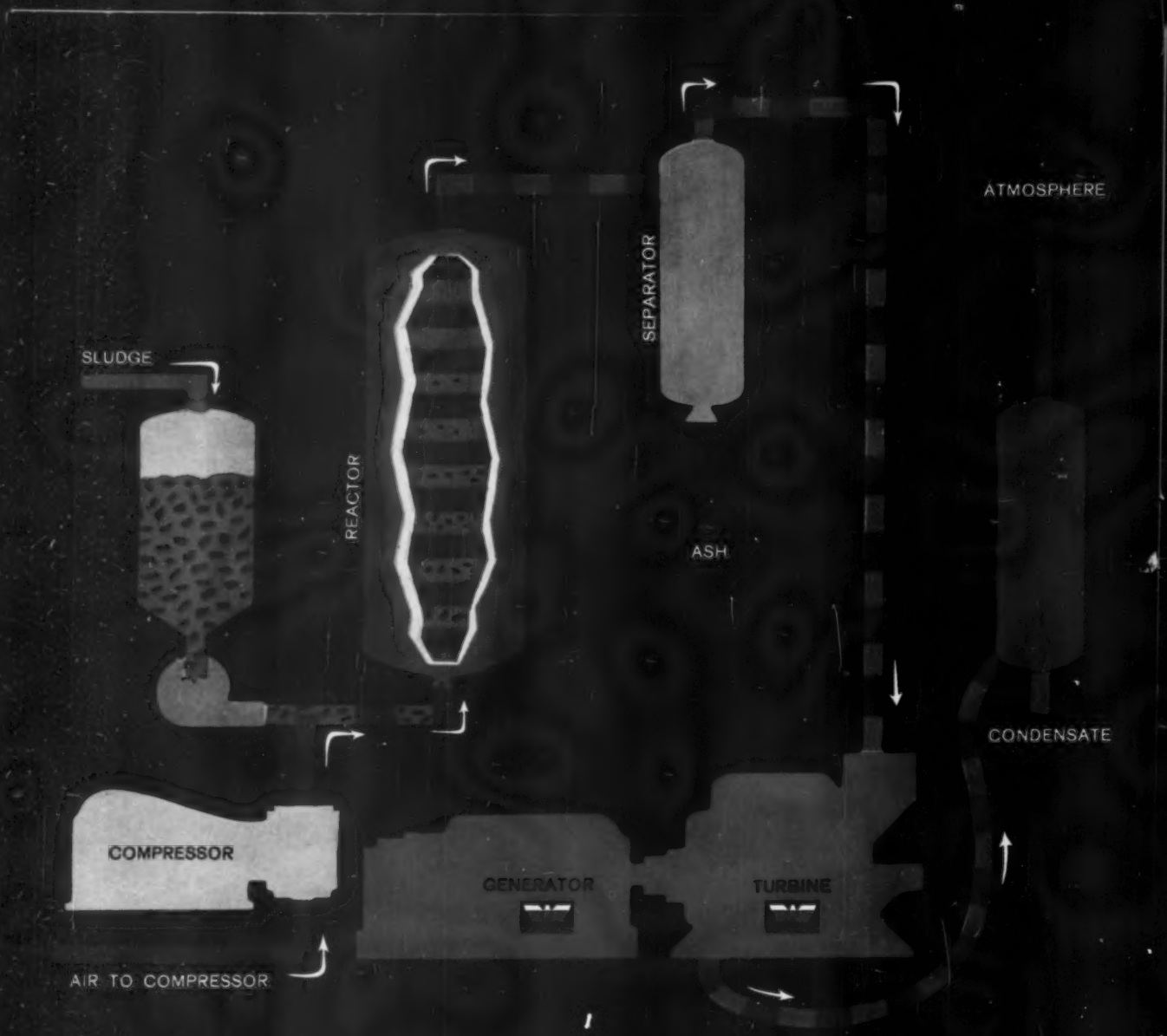
What Fred discovered, of course, was ISLAND CREEK PRECISIONEERED COALS. They have substantially reduced steam costs in plant after plant. They can do it in yours. Because *your burning equipment* is where the whole PRECISIONEERING process begins and ends. Superior seams of coal are mined and prepared precisely to your requirements, based on our engineering and evaluation studies. You get top efficiency, and lowest net cost per 1000 lbs. of steam. Write or phone to arrange a discussion of your steam cost reduction. No obligation, of course.

ISLAND CREEK Precisioneered Coal

You can depend on Island Creek . . . a career company dedicated to coal

ISLAND CREEK COAL SALES COMPANY, Chafin Building, Huntington 18, West Virginia • Chicago • Cincinnati • Cleveland • Detroit • Greensboro • New York • Pittsburgh

For more data circle 559 on Post Card



Worthington turbine generator and Zimmermann process produce...

FREE POWER FROM WASTE

Take nearly any combustible organic waste in aqueous solution. Then react it with air under high pressure. Then use the resulting gas and steam mixture to drive a Worthington power recovery turbine. With sufficient organic content you'll get enough power to run the disposal process—and in some instances a great deal more, too.

In Chicago a $12 million plant built on this Zimmermann Process* will dispose of 200 tons a day (dry basis) of sewage sludge. But the process runs equally well on many industrial organic wastes; for example, waste pulp liquor from a pulp mill and on much smaller tonnage than the large Chicago installation.

Key factor in process efficiency is the direct power recovery from gas-steam mixture produced by the reaction. In the Chicago installation, this mixture will drive a Worthington 12,500 kw. turbine generator.

Why was the Worthington turbine generator unit chosen? Because Worthington turbine specialists lead in designing turbines for power recovery from any gas mixture, including the gas-steam produced here. Because a Worthington generator has quality not exceeded by any other generator manufacturer today. And because of Worthington's reputation for extreme reliability in the industrial turbine field.

For further information about any power recovery turbine application, write or call Worthington Corporation, Turbine Division, Dept. 48-13, Wellsville, New York.

*The Zimmermann Process is patented and licensed by Sterling Drug Inc., N. Y. C., N. Y.

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

For more data circle 560 on Post Card